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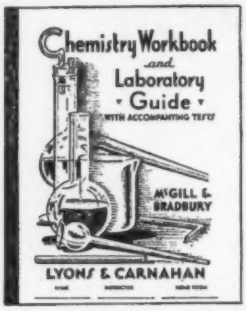

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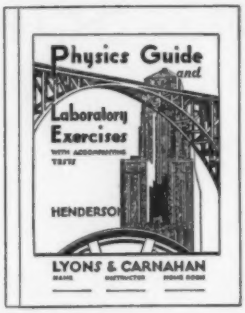

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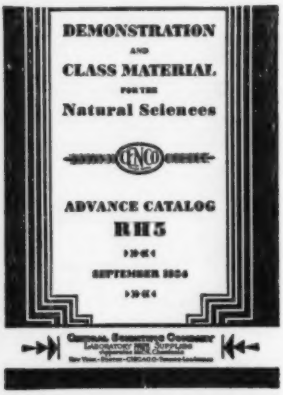

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Volume 18 OCTOBER, 1934 Number 3

SOME FINDINGS FROM STUDIES IN THE FIELD OF COLLEGE BIOLOGY*

RALPH W. TYLER

Ohio State University

For several years the Departments of Botany and Zoology of the Ohio State University have been studying means for improving the effectiveness of instruction in their elementary courses. Recognizing that any comprehensive evaluation of teaching effectiveness demanded measurements of the progress of students this program of study has been intimately connected with the development of more satisfactory examinations. It is traditional to conceive of an examination as consisting of a series of questions or exercises to which the student writes answers. When the purpose is to determine as accurately as possible what students have learned, we may think of the examination as any means of obtaining valid evidence of the degree to which students have attained the desired objectives of instruction. Hence, the fundamental task in constructing tests of student achievement is to make certain that all of the important objectives of the subject and course are adequately measured.

The first step in the task of improving examinations in botany and zoology was to define the objective which students were expected to attain as a result of instruction in these subjects. For purposes of examination construction the statements of the objectives were expressed in terms of the behavior expected of students as a result of instruction in the course; for example, one objective expected of students is an ability to recall important facts, principles, and technical terms. A second is an ability to formulate reasonable generalizations from the specific data of an experiment; a third is the ability to plan an experiment which might be used to test a given hypothesis in botany or in zoology; a fourth, the ability to apply general principles to new situations; a fifth, skill in the use of the microscope; and so on. The nature of these objectives determines the

* Presented at the National Assoc. for Research in Science Teaching, NEA meeting, Cleveland, February 27, 1934.

variety of achievement tests to be constructed. Measurements of the information which a student recalls may be made with a paper-and-pencil examination, while a test of skill in the use of the microscope would require a different set-up. There are many types of examinations required in college achievement tests as indicated by the projects in examination improvement which are in progress in several departments of the University. Thus far these departments have formulated at least ten major types of objectives each of which will probably require different types of examinations. These are:

1. Acquisition of information which includes recalling specific facts, terminology, and statements of general principles.
2. Reasoning or utilizing scientific method which includes induction, testing hypotheses, and deduction.
3. Locating relevant data which includes a knowledge of sources of usable data and skill in getting information from appropriate sources.
4. Skills characteristic of particular subjects which includes laboratory skills in the sciences, mathematical skills, and the like.
5. Applying standards to technical performance which includes the knowledge of appropriate standards, ability to evaluate the relative importance of several standards which apply, and skill in applying these standards.
6. Making reports which includes the necessary skill in reporting projects in engineering or reporting experiments in science, and the like.
7. Consistency in applying a point of view which is deemed important in courses in philosophy.
8. Interest in important social problems which includes interest in reading about and in investigating problems.
9. Enjoyment in wholesome recreational activities which includes enjoyment of literature, music, and art.
10. Character which is inclusive and may well involve many specific factors.

When the examinations in use were compared with the list just given, several types of objectives were found to be untouched by the tests. Nevertheless, if these are the types of objectives which students should attain in their college work, no examination is adequate which fails to provide evidence of their attainment. It has therefore been necessary to develop new types of examinations for many of the objectives. We are still engaged in this task.

A more detailed description of the examinations constructed in the elementary biology courses has already been published.[1] These tests provide evaluations of student achievement representing a variety of objectives, and are not restricted to tests of facts remembered. Although their improvement is a matter of continuing effort, all of the examinations now in use in these courses can be scored with a high degree of objectivity, and none of them have coefficients of reliability less than .94. The examinations are being refined through continuous trial and revision so as to give as exact a measure of student progress in learning as possible. In general, it has been found that such small increases in achievement as those resulting from only three days of instruction can be measured by these tests; hence, they can be used to evaluate with some accuracy the efforts to improve instruction.

Since the instructors in the biology department are studying a variety of problems involved in improving their teaching effectiveness it is difficult to select for report the studies which may be of greatest significance. My own relations to the program have been those of a technician providing assistance in the construction of the examinations and in the setting up of the experimental conditions so that my interpretations may not always represent the conclusions of the instructors concerned. Obviously, there is nothing final in this report for it has been prepared while the methods of measurement are in process of development and the modifications of teaching procedures are under way.

PERSONAL INTERVIEWS

The possibility of losing the personal contact between instructors and students is a danger threatening every large university. To offset this representatives of both faculty and student body favored a plan for the instructor to interview personally each student in his class. This plan was given specific recommendation by the Council of Junior Deans during the year 1928–29, and instructors in many elementary courses set up interview sections; that is, particular classes in which a systematic plan of interviewing each student was followed. Because little was known regarding effective techniques for this interviewing and in order to allow wide individual flexibility so that the interviews would not become formalized or mechanical, no uniform method of conducting interview sections was followed. Hence, the only factor common to all was the provision for personal contacts between instructor and student.

Opinions of both instructors and students as to the value of interview sections were collected as the trial continued. The overwhelming majority of both groups favored the personal interviews, the instructors maintaining that it gave them a closer understanding of the students' problems and needs so that teaching might be better adapted to a particular class, while the students claimed that it gave them a realization of the humanness and sympathetic purpose of their instructors which was a stimulus to greater effort.

In addition to these opinions, evidence of the effect of interview sections in botany and zoology upon student achievement was obtained. During the Spring Quarter, 1930, four instructors in Botany 401, the first half of the elementary course, and two instructors in Botany 402, the second half of the elementary course, conducted interview sections. Each of these instructors taught one interview section and two sections in which no interviewing was done. This made it possible to compare the achievement of students in interview sections with corresponding students taught by the same instructor in sections where no systematic plan of interviewing was followed. The students chosen for comparison in Botany 402 were pairs so matched that both members of the pair had the same percentile ranking on the Ohio State University Psychological Test, had received the same mark in the first half of the course, Botany 401, were of the same sex, and were taught by the same instructor. One member of the pair was in an interview section while the other was not. The summary of the examination scores made in Botany 402 by the paired students under each instructor are given in Table I. It

TABLE I

SUMMARY OF THE EXAMINATION SCORES RECEIVED BY THE PAIRED STUDENTS IN BOTANY 402

Type of Test	*Brown (14 Pairs)*	*Williams (31 Pairs)*	*Total (45) Pairs)*
(1)	(2)	(3)	(4)
	Interview Sections		
First test	79.7	82.9	
Second test	62.4	84.8	
Final examination	62.4	58.9	
Mean of all tests..	68.2	68.9	68.7
	Non-Interview Sections		
First test	74.6	76.8	
Second test	56.1	61.1	
Final examination	56.2	55.7	
Mean of all tests..	62.3	64.5	63.8

will be noted that 45 pairs of students were found in the classes of the two instructors who could be matched in this way. The mean of the scores on all the examinations made by those in the interview sections was 68.7, the mean for those not in the interview sections was 63.8. The difference is 4.9, and the probable error of this difference is only .6. This difference is

much too great to be attributed to the small size of the sampling. It is obvious, then, that the students in the interview sections made higher scores on the examinations in Botany 402 than did those in the sections where no systematic interviewing was done. This difference is approximately equal to half of the difference between an average mark of C and an average mark of B.

In Botany 401 students chosen for comparison were pairs who were of the same sex, who had the same percentile ranking on the Ohio State University Psychological Test, and who were taught by the same instructor. One member of the pair was in an interview section while the other was not. Table II is a summary of the examination scores made in Botany 401 by the paired students under each instructor. This comparison makes clear that the mean of the scores on all the examinations in Botany 401 made by the 101 students in the interview sections was 78.6, while the mean of the scores for the students who were not in interview sections was 74.6. This difference of 4.0 is slightly less than the difference found in Botany 402. Since the probable error is only .4, the difference is too great to be due solely to errors in sampling. It is again apparent that the students in interview sections made higher achievement in their examinations than those not in interview sections.

TABLE II

SUMMARY OF THE EXAMINATION SCORES IN BOTANY 401 MADE BY PAIRED STUDENTS

Type of Test	*Brown (26 Pairs)*	*Tiffany (27 Pairs)*	*Williams (25 Pairs)*	*Blaydes (23 Pairs)*	*Total (101 Pairs)*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	Interview Sections				
First test..	77.7	74.0	81.6	79.1	
Second test	81.6	77.7	77.3	80.4	
Final examination .	81.2	76.1	79.4	78.1	
Mean of all tests ...	80.2	75.9	79.4	79.2	78.6
	Non-Interview Sections				
First test..	72.2	72.2	75.5	71.2	
Second test	76.1	77.8	78.1	74.7	
Final examination .	75.1	73.0	76.4	72.3	
Mean of all tests ...	74.5	74.5	76.7	72.7	74.6

These first two comparisons were made during the year 1929–30 when the examinations used in botany were objective, but before they had been rebuilt explicitly on the basis of the objectives which students were expected to attain in the course. With the development of these new diagnostic tests during the following year it was possible to make a more exact comparison of the interview sections, and the sections in which no systematic plan of interviewing was followed. The first comparison had been made on the assumption that students matched in the way described could be expected to make similar achievement on the course examinations when they were taught by the same procedure. Any difference in achievement between interview and non-interview sections was attributed to the interviewing. For the second comparison which was made in the Autumn Quarter, 1930, various bases for matching students were tried in an effort to discover a basis sufficiently accurate so that the actual means of the achievement of groups so matched were nearly identical when these groups were taught by the same procedures. If such control factors could be discovered, it would then be possible to compare the achievement of students in interview sections with corresponding students not in interview sections, and differences in mean achievement could reasonably be attributed to the effects of interviewing.

To control enough factors so that several groups chosen with these factors constant will be found to have identical mean achievement scores is a difficult task. The

intelligence percentile alone did not prove to be an adequate basis for matching students. After experimenting with various combinations of factors it was discovered that by matching students so that the two members of each pair were similar with respect to instructor, general plan of instruction, sex, intelligence percentile within 5 points, and score on the first mid-term test within 5 points, the control thus obtained was exact enough so that two random groups of 25 students each when so selected had mean total scores on corresponding parts of the later course examinations within .5 points. Using this basis for control, pairs of students were chosen so that one member of the pair was in an interview section, while the other was not, but both members of the pair had been taught by the same instructor, were of the same sex, were within 5 points of the same intelligence percentile, and had made within 5 points of the same scores upon the first mid-term test.

Fifty-three pairs of matched students were thus selected. A comparison of their scores on the examinations in Botany 401 is given in Table III. In this comparison

TABLE III
MEANS OF TEST SCORES IN BOTANY 401 FOR FIFTY-THREE PAIRS OF STUDENTS

Type of Test	*Interview Section*	*Non-Interview Section*
(1)	(2)	(3)
Second test	67.0	63.0
Third test	64.4	62.2
Final examination ...	129.4	121.3
Total of all tests	260.8	246.5

it is clear that the 53 students in the interview section show a mean total achievement on the second and third tests and the final examination which is 14.3 points higher than the mean total achievement of corresponding students where no systematic plan of interviewing was adopted. The probable error of this difference was only 1.8. It is apparent, then, that the difference is too great to be attributed solely to errors in sampling. This difference was then compared with the distribution of letter-marks for the Autumn Quarter to determine what such a difference in test scores means in terms of the letter-marks assigned students. It was found that a difference of 24 points on these examinations was the equivalent of a difference between a mark of C and a mark of B. Hence, a difference of 14.3 is equal to .6 of the difference between a C and a B. We may conclude, then, that the students in these interview sections did .6 of a letter-mark better on the later examinations than did corresponding students; that is, the members of the pairs who were not interviewed regarding the difficulties they encountered during the course.

During the Autumn Quarter, 1930, a comparison was also made of students in elementary zoology who were in interview sections with corresponding students who were not. It was also necessary in the zoology comparison to establish controls sufficiently accurate so that the means of the achievement of two matched groups were the same when all control factors were held constant. If, then, a factor such as interviewing were varied between the two groups, corresponding differences in mean achievement could reasonably be attributed to this variable factor. As with botany, it proved to be a difficult task to control enough factors so that the matched groups would be found to have almost identical mean achievement scores. The intelligence percentile alone was found not to be adequate for such exact control.

Eventually, it was necessary to set up two types of controls, one for information, including terminology, the recall of specific facts, and location of structures, and another for scientific method, including forming generalizations, drawing inferences, and applying principles. To form an adequate

control for information learned, students were matched so that two members of each pair were similar with respect to instructor, general plan of instruction, sex, intelligence percentile within 5 points, and score on Parts I, II, and III of the pre-test within 5 points. These were the parts of the pre-test covering informational aspects. This gave a control so exact that the means of the total scores on the informational parts of the course examinations made by two matched groups of 25 students each who were paired in this way were found to differ by only .8 points. As a basis of control for scores on the parts of the examinations which test ability to apply scientific method students were matched so that the two members of each pair were similar with respect to instructor, general plan of instruction, sex, and score on Part IV of the pre-test within one point. This part of the pre-test dealt with the use of scientific method. This gave a control so exact that the means of the total scores on the scientific method aspects of the course examinations made by the two matched groups of 25 students each who were paired in this way were found to differ by only .15 points. With such exact controls it is possible to make a more exact evaluation of the achievement of interview sections. Using these bases of control, students were then chosen so that in each pair one member of the pair was in an interview section and the other member was taught by the same instructor but was not in an interview section.

The results of these comparisons with reference to the informational aspects of the course are shown in Table IV. This table shows that the 145 students in the interview sections made a mean achievement of 4.61 points higher than the 145 students who were not in interview sections. The probable error of this difference was only .53, so that the difference cannot be attributed solely to errors in sampling. This difference of 4.61 is the equivalent of approximately .5 of the difference between the mark of C and the mark of B. The table also shows that the relative effectiveness of the interview sections was greater for certain instructors than for others. An examination of the original data sheet reveals the fact that two instructors through interviewing increased the achievement of their best students, while three instructors seemed to stimulate the poorer students through interviews.

Interview and non-interview sections in zoology were next compared with reference to achievement on the parts of the examinations testing the student's ability to apply scientific method, that is, the ability to formulate generalizations, to draw inferences, and to apply principles. A summary of these comparisons is also given in Table IV. This table shows that the

Table IV

Means of Test Scores in Zoology 401 Made by Paired Students

Type of Test	*Interview Section*	*Non-Interview Section*	*Difference in Favor of Interview Sections*
Information 145 pairs .	77.97	73.36	4.61 ± .53
Scientific Method 155 pairs	24.43	20.95	3.48 ± .42

students in interview sections made a mean achievement on the parts of the tests dealing with scientific method 3.48 points higher than students in non-interview sections. The probable error of this difference is only .42, so that the difference cannot be attributed solely to errors in sampling. This table also makes it clear that the relative effectiveness of the interview sections varies with the instructor. An examination of the original data sheets shows that two instructors stimulate their better students in interviews more than their poorer students, while three instructors get greater gains from their poorer students than from their better students.

These studies in botany and in zoology show that the students in interview sections made a significantly higher mean achievement than corresponding students who were in sections where no systematic plan of interviewing was followed. These comparisons were made with 199 pairs of students in botany taught by five different instructors, and with 155 pairs of students in zoology taught by six instructors. In both subjects the average achievement of students in interview sections was not only higher by an amount which was statistically significant, but the average difference was equivalent to approximately half of the difference between the mark of C and the mark of B.

REMEDIAL INSTRUCTION

For students encountering serious difficulties in elementary zoology courses, the department provided a remedial laboratory in charge of Mrs. Meyers, to which students might go at any free hour. Instructional materials of many types were provided in this laboratory. The procedures used by Mrs. Meyers have been described more fully elsewhere.[2] During two quarters, an evaluation was made of the effect of this remedial instruction upon the achievement of students. The first comparison was made of the students who were given remedial instruction during the Autumn Quarter in Zoology 401 with corresponding students who were not given this instruction. To establish controls sufficiently accurate for this comparison the bases of control described in the previous section on the evaluation of interviewing were used. There were two types of control, one for informational portions of the course examinations and the other for those parts of the tests involving scientific method. To compare information scores students were matched so that the two members of each pair were similar with respect to 5 points, and score on Parts I, II, and III of the pre-test within 5 points. These were the parts of the pre-test covering informational aspects. One member of each pair was given remedial instruction by Mrs. Meyers, and the other member was not. The results of these comparisons are given in Table V. This table shows that the 42 students who were given remedial instruction made a mean achievement which was 7.02 points higher than the students who were not given remedial instruction. The probable error of this difference is only .81, so that the difference cannot be attributed solely to errors in sampling. This difference of 7.02 is the equivalent of approximately .8 of the difference between the mark of C and the mark of B.

TABLE V
MEAN SCORES ON INFORMATIONAL AND SCIENTIFIC-METHOD PARTS OF THE TESTS MADE BY STUDENTS WHO HAVE HAD REMEDIAL INSTRUCTION AND BY STUDENTS WITHOUT REMEDIAL INSTRUCTION

	Information (42 Pairs)		*Scientific Method (44 Pairs)*	
	Remedial Help	*No Remedial Help*	*Remedial Help*	*No Remedial Help*
(1)	*(2)*	*(3)*	*(4)*	*(5)*
First test	39.06	41.32	4.12	5.26
Second test ..	17.71	13.33	2.34	1.14
Final examination	14.54	9.64	15.01	12.22
Total	71.31	64.29	21.47	18.62

Students given remedial instruction were next paired with students not given this instruction using the basis of control previously described in comparing achievement on the parts of the examination involving scientific method. The results of these comparisons are also given in Table V. From this summary it is apparent that the students given remedial in-

struction made a mean achievement on the parts of the tests involving scientific method which was 2.85 points higher than the students not given remedial instruction. The probable error of this difference is only .54; so that the difference cannot be attributed solely to error in sampling. An examination of the original data sheets show that some students made much greater gain than the mean, while others showed no improvement. Although only those students were selected for comparison who had been given remedial instruction at least two times during the quarter, some of these did not come in the remedial group until the middle of the quarter; so that the difference in achievement is even more striking.

To compare the achievement of the students given remedial instruction during the Winter Quarter in Zoology 402 the basis of control was used which was developed for other records in Zoology 402. It was again necessary to make separate comparisons with respect to informational parts of the course examinations and the parts involving scientific method. To compare informational scores students were matched on the basis of their mark made in Zoology 401, the percentile ranking on the Ohio State University Psychological Test, the score made on the informational parts of the pre-test, the instructor, and the plan of instruction. These controls were exact enough so that the mean difference between the scores on the informational parts of the course examinations made by any 10 pairs of students matched in this way and not given remedial instruction was not greater than 3 points. The results of this comparison are: the 31 students who received remedial instruction got mean total scores on informational parts of tests in Zoology 402 of 172, while the students not given remedial instruction received an average score of 156. It is evident that the 31 students who were given remedial instruction made a mean achievement of 16 points higher on the informational aspects of the examinations in Zoology 402. This is equivalent to .46 of the difference between the mark of D and the mark of C. The probable error of this difference is only 2 points, so that the difference cannot be attributed solely to errors in sampling. The Winter Quarter students in Zoology 402 were next compared with reference to achievement on the scientific-method parts of the course examinations. The basis of control was to match students with reference to mark received in Zoology 401, percentile ranking on the Ohio State University Psychological Test, score made on Parts I and II of the pre-test, general plan of instruction, and instructor. The achievement of scientific method was determined by the score made on those portions of the later examinations which tested aspects of scientific method. The results of this comparison were as follows: mean total scores on parts of tests in Zoology 402 involving scientific method made by the 27 students who were given remedial instruction was 21, while the mean for the 27 students who were not given remedial instruction was 10. This shows that the 27 students who were given remedial instruction made a mean achievement of 10 points higher than corresponding students not given remedial instruction. The probable error of this difference is only 2 points. This is equivalent to .41 of the difference between the mark of D and the mark of C. It is thus apparent that the students in Zoology 402 who were given remedial instruction made higher achievement in both parts of the examination than corresponding students not given this instruction.

This preliminary evidence is all that is yet available to determine the effect of the program of remedial instruction. In both quarters the students given remedial instruction made higher scores on the examinations. Whether this improvement is more or less permanent is not yet known, but the permanency of these differences is under investigation.

PERMANENCE OF LEARNING

Another important problem in higher education is the permanence of learning. Early investigations of the learning of nonsense syllables showed a rapid rate of forgetting as soon as the learning exercises were discontinued. Studies of the retention of information acquired in college courses have been made in several universities, but little attempt has been made to compare the degree of forgetting which takes place with reference to different types of material acquired by college students. Both the botany and the zoology departments at the Ohio State University have been interested in this problem. The results of the study made last year in zoology are the only ones thus far available but each year the same procedure will be followed in both biology departments.

The first of these studies was made by giving an examination in June to 82 students who had taken the elementary zoology course the previous year and who had taken no course in zoology in the succeeding fifteen months. The students, both with reference to average marks and spread, were typical of those enrolled in the elementary zoology course.

The accompanying table presents their average scores on this retest together with the scores which they made when taking the course. It is clear from these results that specific information, which is represented by exercises requiring the naming of animal structures, is most quickly forgotten, that information of more general application is more permanent, and that during the fifteen months' period there was no loss in the ability of students to apply important zoological principles to new situations or to interpret data obtained from experiments. If these results are substantiated by further investigations, it is clear that the permanent results of the college education are not the specific items of information recalled, and that the organization of courses and the development of examinations should center around those objectives which are found to have more permanent value in college educa-

TABLE VI

COMPARISON OF THE RESULTS OF THE COURSE EXAMINATIONS, THE TEST IN JUNE, 1932, AND THE STANDING OF STUDENTS AT THE BEGINNING OF THE ZOOLOGY COURSE

Type of Examination Exercises	*Mean Scores at:*			*Per cent of the Gain made in the Course which was lost by June, 1932*
	Beginning of Course	*Time of Course Examinations*	*June, 1932*	
1. Naming animal structures pictured in diagrams	22.2	61.8	31.4	76.8
2. Identifying technical terms	19.7	83.1	66.5	26.2
3. Recalling information				
a. Structures performing functions in type forms	13.3	39.3	33.9	20.8
b. Other facts	21.4	62.6	54.1	20.6
4. Applying principles to new situations	35.2	64.9	65.1	Gain 0.7
5. Interpreting new experiments.	30.3	57.3	64.0	Gain 24.8
Average for all exercises in the examination	23.7	74.4	63.3	21.9

tion. A substantial justification of teaching students to apply the scientific method is the relative permanence of that learning.

Data presented in this report should make clear the general method by which change in procedures in botany and zoology are being evaluated. The improvement of examinations makes it possible to determine the effect of changes in instructional methods more accurately. As the examinations are constructed to measure the various type of attainment which students are expected to achieve in these classes it becomes possible for the evaluation to be increasingly more comprehensive. As experimentation is continued with methods of pairing students by which more accurate controls may be set up these controlled studies improve in validity. All of these things are essential to more adequate evaluations of instructional procedures. Hence, this is only a report of progress made by these two departments in developing a continuous program of evaluation of definite efforts to improve instruction.

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THE SCIENCE TEACHER'S SCHOLARSHIP AND PROFESSIONAL TRAINING

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The topic assigned to me is so broad that I might easily be expected to consider the scholarship and professional training requisite not only for a teacher of chemistry in high and other secondary schools but also for teachers of the other sciences usually included in a high school curriculum. Increased attention is given to improving the instruction of pupils in college, so I might be expected by some to cover that field also. Therefore, it seems wise for me to cover a cross section of this wide field and devote the bulk of my remarks to the training of those teachers who are to teach elementary, (first year) chemistry. This will cover the high school field primarily, but lap over into the college freshman field. Many of the points I wish to cover for chemistry will apply equally well to the other sciences, and additional points can easily be included to cover the other sciences.

In considering the preparation of the chemistry teacher for his life work let us take up, first, the preparatory or undergraduate period, during which time he is laying the factual foundations for future activities and, second, the professional stage, during which he is carrying on his chosen work and building on experience to attain greater results.

First, a chemistry teacher must like chemistry. This implies a thorough knowledge of so much of the subject as is necessary to do one's life work effectively, plus a little more chemistry as a margin of safety, because there are usually one, two, or three students in every class who are more advanced than the rest of the class.

Those of us who are old enough to remember how little chemistry we needed to teach our pupils thirty or thirty-five years ago to prepare them to pass the entrance examinations for college will realize to what extent the entrance requirements have been increased during this period. It is evident, therefore, that the subject content qualification of the chemistry teacher of today is of considerable importance.

That the knowledge of subject content is not likely to be reduced in the future is evident, (1) from the possibly greater interest of modern youth in things scientific,

(2) from the increasing reluctance on the part of the student to accept statements simply because "the teacher says so," (3) from the recent increase in printed scientific matter of a popular nature for the lay reader and (4) from the enormous amount of newly revealed scientific knowledge, much of which many high school teachers, some school administrators, and some textbook publishers, feel should be touched upon in the high school classes often unfortunately at the expense of a more thorough knowledge of some of the basic principles and fundamental facts of science.

It would seem that the chemistry teacher should have had, as a minimum, college courses in general inorganic chemistry, organic chemistry, qualitative analysis, quantitative analysis, and perhaps physical chemistry—the inorganic because of the basic principles and general information involved, the organic because of the important rôle organic substances play in the life of today, the two analytical courses because of the practice in laboratory technique they give, and the physical chemistry because of the increasing work on the border line between physics and chemistry.

The foregoing is the speaker's personal opinion, but it corresponds closely, though not exactly, with the findings of the Committee on Preparation of High-School Chemistry Teachers of the Division of Chemical Education of the American Chemical Society—a committee which conducted a comprehensive investigation a short time ago and which published a detailed statement of its findings in the *Journal of Chemical Education*.[1] It agrees similarly with the Preliminary Report of the Committee on Education of the American Institute of Chemists[2] and with a number of individual and committee pronouncements. In particular it corresponds well with the list of courses in chemistry prescribed by 56 institutions and taken by prospective teachers majoring in chemistry in these institutions as set forth in W. E. Peik's "Supplementary Report on the Curricula for the Education of Teachers in Colleges and Universities"[3] which is a part of the National Survey of the Education of Teachers being conducted by the United States Department of the Interior.

sum from the total number of courses re-

I have in mind the teacher who is fortunate enough to teach only chemistry. In that case he would do well to have other undergraduate courses in chemistry which are ordinarily given in college in order to give him an added background. Mathematics should have been pursued through analytical geometry. Of course English should have been pursued each year in college up to graduation with special emphasis on the ability to express one's self in clear and correct manner. Ability to read scientific French and German is still a desirable and necessary accomplishment. One, two, or three courses in the methods of teaching and in education are desirable and usually helpful, and are often required by law for teaching in a public school system. If there is room and time for any "remaining subjects" the prospective teacher should certainly be given opportunity to choose those which appeal to him.

All the foregoing applies to the person for whom chemistry is to be the only subject on his teaching schedule. How about the high school teacher who must teach other subjects in addition, for unfortunately there are still some such requests in the United States? In E. W. Phelan's article on "The Status of Chemistry and the Chemistry Teacher in the Ohio High Schools,"[4] he points out that in from two-thirds to three-quarters of the county and city high schools investigated, chemistry teachers had to teach one, two, or three other subjects; and in some cases as many as five or six. Let us not for a moment assume that Ohio is the only state in which these conditions exist, for the evidence is much to the contrary.

What is the solution? *Theoretically,* the

prospective teacher should specialize in college subjects in proportion to the other subjects, which I have just indicated. He should specialize in chemistry, but *practically*—well, that is another question. He simply does not qualify, and we hear and read of what A. M. VandeVoort in her article on the normal school and teachers' college calls "the inadequacy of the preparation of teachers."[5]

In this connection A. J. Currier says:[6] "It is now coming to be recognized that the well-trained high school teacher of chemistry, or indeed of any other field of science, should possess: (1) a thorough knowledge of the fundamentals of the subject; (2) some training in the allied branches of science and a clear understanding of the interrelationships between these sciences; (3) some definite training in the presentation of the subject and a clear conception of what results are to be accomplished in the teaching of chemistry, which of course implies (4) an understanding of the pupil and of modern society."

Match with this what F. C. Coulson says the chief aims of elementary chemistry should be:[7] "(1) to give the pupils an idea of the importance and significance of chemistry in our national life, (2) to give information to definite service to home and daily life, (3) to develop specific interests, habits, and abilities which should be contributed by all sciences, (4) to secure an element of continuity in science by knitting together previous science work through recall and through the presentation of principles—new ones and elaboration on old ones, and (5) to help the student discover whether he has an aptitude for further work in pure or applied science and to induce such pupils to continue science studies in the university or technical school."

Let us assume that our typical high school teacher must also teach physics. We must then duplicate, for physics, the minimum specialized courses to be taken in college, the qualities which the teacher should possess, and the chief aims of the science in question which we have just enumerated for chemistry.

Let us assume that the headmaster or school committee wishes to have a strong and well-rounded out science department in the school. We must then duplicate for biology the three lists just mentioned. Then perhaps we will have the kind of teacher L. C. Newell had in mind when he included in his "Teacher's Vow": "I will see the good in all pupils and lead them on to higher attainments."[8]

But wait a minute. Let us count the cost. Let us study the college catalog and make a list of the courses which will supply the material and training outlined above for the three sciences, and then deduct the sum from the total number of course required for the degree to discover how many courses remain for general and broad culture. Perhaps the remainder will have a minus sign before it. Here is a real problem. Let us be thankful that it is under investigation and let us pray that the solution will be workable.

One of the conclusions reached by the Committee on Preparation of High School Chemistry Teachers[9] is that "more extensive training and other sciences is urgently needed in many cases" and "these needs should be met either by decreasing the requirements in educational courses, by increasing the number of credits required for graduation (above the 120 minimum), or by graduate study." This report, by the way, is full of helpful suggestions for the solution of this problem. E. G. Dexter in the Fourth Yearbook of the National Society for the Scientific Study of Education[10] feels that the high school teachers must soon invest in "at least four year's time in the academic side of college work, with at least one year's graduate work devoted largely to a theoretical and practical study of school problems." However, the last mentioned is only one opinion on the problem.

In this connection it may be profitable to study the tables of data covering curricula requirements for the different sciences as was set forth in Peik's National Survey[11] for colleges and universities, previously mentioned. The report by Rugg[12] covering a similar survey for teachers colleges and normal schools is equally enlightening. But time does not allow even a synopsis or abstract of their findings. The reports need to be studied at one's leisure. One interesting item, however, stands out rather prominently, namely, that among the aims and objectives of chemistry courses for prospective teachers the following have high percentages, acquisitions of facts and meanings, principles of subject, aims and problems of the subject, while the following have rather low percentages, methods of teaching subject, background for teaching, and practice in teaching. The same relative proportion holds for teachers colleges and normal schools with perhaps, as might be expected, a slightly less percentage on the teaching aims.

Are courses in education the best sources of help? J. O. Frank[13] says: "Since chemistry teachers have to teach in high school, it is obvious that they must thoroughly understand teaching at the high-school level and especially the teaching of high school science. We must provide for not only an understanding of secondary education but also technic in teaching." On the other hand both Brownell and Wade[14] say: "It is very likely that theory and methods courses in education have been so divorced from whatever subject matter is to be taught as to become mere abstractions, and in many cases but a shibboleth of the vocabulary of education, lacking in vital relationship and significance."

That certain courses in education are requisite for the prospective teacher no one should be foolhardy enough to deny. The *choice* of such courses, however, is an important matter. The most valuable course on teaching methods I took in college was not on the college curriculum. There was only one student enrolled in the course, and the content (the things, topics or principles studied) was made up of the faculty members giving the courses I was taking. The aims and objects of the course included the obtaining of pointers for my future career. It was a very profitable course. I learned more about how *not* to do things when trying to make a subject clear to others. I began to see dimly what has since become more than evident, that no two classes are alike, that no two members of a class are exactly alike, and that the teacher must fit, adapt, or devise his methods to the cases before him, remembering that there are basic underlying principles of "making things clear." B. S. Hopkins[15] has said this better than I can: "A good teacher is the most important factor in any chemical course of study. Expensive laboratories, elaborate equipment—and skillfully arranged courses of study are of little value in the teaching of chemistry unless they are presided over and administered by the mind of an individual who knows and loves chemistry and who has some skill in the science and art of imparting his knowledge to others."

This leads to one suggestion which might fit in here. There seems room for a course in methods and in tackling teachers' problems by a hand-picked member of the chemistry department. This course should cover not the strictly chemical textbook material, nor the abstract consideration of methods, but a wise mixture of chemistry and methods, using the former to illustrate the latter, and the latter to show how the former should be presented. This would knit the two in a way that separate courses in pure chemistry and courses in education can probably never accomplish. Such a course could take up with profit some of the problems which confront every teacher when he gets out into a job and must decide for himself, such as the discrepancy between texts in the order in which unit topics are

presented, uneven emphasis on topics, proper tie-up between laboratory work and text work, suitability of certain experiments to the abilities of the pupils being taught, to what degree of refinement quantitative experiments should be carried, reasons why the results of certain experiments usually differ from the statements in the text, and numerous other perplexing questions which the teacher with a full schedule has not the time to investigate. F. D. Curtis in the *Thirty-First Yearbook* suggests additional similar topics.

Such a course might obviate the conditions Currier[16] speaks of when he says: "Many teachers look back upon their first year of teaching with a feeling that it was largely a period of trial and error in which mistakes were made, usually at the expense of the students. Effective teaching of any kind, and particularly in the teaching of chemistry in secondary school—in the case of the majority of teachers, is gained in the hard school of experience."

W. B. Frazier[17] presented a comprehensive review of the present status of teacher training in the United States at the Cincinnati meeting of the American Chemical Society, saying among other things; "There is a promising field of research in the whole matter of how to teach" and he listed a dozen conclusions from recent studies. He was talking about teaching in college but his remarks were equally applicable to the secondary field.

Here and there an occasional college or university is attempting to turn out teachers of chemistry instead of placing in a college chair of chemistry a graduate who has had chemistry as a major but who has had no specific training or preparation for the teaching part of the job. Unfortunately these attempts have usually related to the college field only, instead of to the secondary field. Fortunately a few colleges are beginning to see the light in the secondary school direction. May that light grow brighter!

That this subject of the teacher's scholarship and professional training is timely and important is evidenced by a number of facts. Some of these have been mentioned. Others will suggest themselves naturally. Let me add one more specific case, that of the committee on Professional Training appointed by the Central Association of Science and Mathematics Teachers.[18] One of their recommendations reads that: "courses offered in the teaching of high school subjects or in practice teaching be taught or supervised by instructors who have been trained in subject matter as well as in methods of teaching."

As some of the other steps in the right direction in the solution of this problem we might mention: (1) a greater and constant effort on the part of the teacher to perfect himself in the knowledge of his subject and other directly associated tools of the job, (2) sharing our successes and problems with others through joining an association of teachers, (3) educating school principals and boards of education in the varying needs for different subjects, and (4) measuring up to the enlarged opportunities.

Finally, let me close with what seems to me to be the gist of the whole matter—that that person is best qualified to teach elementary chemistry and other sciences as well who has (1) a love for the subject itself, (2) a love for pupils, and (3) a love for the job of passing on the subject to the pupil.

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THE SELECTION OF HIGH-SCHOOL SCIENCE TEXTBOOKS

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The average teacher, when called upon to select a textbook, seldom does so in any systematic manner. Many publishing houses furnish complimentary copies of books for the purpose of having teachers make a careful investigation of the merits of the volumes for classroom use. Teachers receiving such books frequently fail even to give the publishers a courteous acknowledgment of the receipt of the book, still less do they consider making a systematic study of it. Perhaps we should be slow to criticize teachers for this practice, however, when we realize that teacher-training institutions in the past have made little systematic effort to teach prospective teachers how to select a textbook. It is our practice in the Northeast Missouri State Teachers College, in connection with a course in the Teaching of Science, to present as a unit of that course some fundamental principles of textbook selection. Most of the students taking this course are in their senior year. We feel that the results thus far have been encouring.

This unit of the course is begun early in the quarter, and, after the techniques have been fully discussed, the actual study of leading high school textbooks in biology, chemistry, physics, and general science is continued throughout the term as an extra-classroom activity. These books are made available for the use of the students, and each student is encouraged to become familiar with each book on the list. In order that this study may be as systematic as possible a score card has been devised. The major divisions of this card are: (1) Content of the text; (2) Organization; (3) Teaching and Study Helps; and (4) Physical Make-up of the Text. A perfect score is taken as 1000 points, these points being apportioned among the four divisions of the card as follows: Content 350; Organization 350; Teaching and Study Helps 225; Physical Make-up 75.

In studying the content of a textbook, I should first examine the objectives which the author had in mind in preparing the book. This is frequently difficult to discover. Both course and unit objectives should be clearly and definitely stated by the author, though it is quite possible that the teacher may prefer to make certain alterations in them for his own purposes. Given proper objectives well stated, the facts presented should lead to a realization of these objectives.

The book should be illustrated with appropriate, clear-cut pictures, drawings or other illustrative material, so chosen as to lead or contribute definitely to the development of the unit. The development of the unit should also be accompanied by well-chosen exercises and experiments. These can be made to serve as a potent stimulus to constructive thinking.

Attention should be paid to the clearness and accuracy with which facts and principles are presented. An illustration of this may be seen in the following statement found in one high school science textbook: "The dew freezes and forms a snowy looking substance . . . frost." One must not expect that all inaccuracies will be as obvious as this one, but the teacher studying the text should make a systematic effort to discover them if they exist. The presentation of material is often so made that it would hardly be clear to the average high school student. In many cases important principles are developed with much more emphasis on logical than upon psychological development, when it is generally possible to have both. Modern educational psychology has fairly definitely established laws of learning by means of which important facts and generalizations should be developed and mastered. This always involves beginning on the level of learning of the student, and proceeding from that point to the full working out of all essential facts and relationships, and to the final statement of the generalization and its applications to many life situations. All too often the unit opens with a statement of the law or other generalization, after which applications and verification may follow.

As has been stated, the clearness of presentation must be judged in the light of the achievement level of the learner. Too many high school textbooks are but abbreviated college texts. In order for the teacher to be able to judge this point it is generally desirable to make a study of the vocabulary difficulty of the text. This we do by taking a one hundred word random sample of the text. The non-technical words in this sample are checked as to their difficulty by the use of the Thorndike Teacher's Word Book.[1] The technical words are checked as to their difficulty by the use of Powers' "A Vocabulary of Scientific Terms for High School Students."[2] By the use of this technique a fairly accurate measure of the vocabulary difficulty of a textbook is determined. One class reported that the percentage of technical words in a certain high school chemistry text was almost exactly the same as that of a college text written by one of the authors of the high school book, and very much higher than the percentage of technical words found in most of the books under study. We need to remind ourselves that we are asking of our science students a much more difficult task, so far as the mastery of new words is concerned, than the teacher of a foreign language would be likely to ask of his class. Our effort should be constantly toward minimizing rather than increasing this difficulty. We should realize that the mastery of a technical word in science requires the mastering of a concept, and not the mere memorizing of a verbal definition. A mere verbal reaction to a word stimulus in science is wholly inadequate. A mere glossary is not sufficient.

The subject matter presented becomes tiresome and dry unless it is enlivened by the early and frequent correlation of facts and principles with human activity and progress. The transfer value of science study depends almost solely upon the manner in which the

concepts developed have been conditioned in the minds of the students. A concept to be useful must be conditioned so widely that a multitude of possible life situations might become adequate stimuli to set off the carefully developed reaction pattern which the teacher has built up in the mind of the student.

enced teacher would likely prefer to direct the preparation of his own outlines by the students, and yet, it seems to me that the author of a textbook should provide either a suitable topical outline for review purposes, or give leading suggestions by which the student would be guided in doing so for himself. This applies equally well to sum-

TABLE I

NORTHEAST MISSOURI STATE TEACHERS COLLEGE
A SCORE CARD FOR SCIENCE TEXTBOOKS

Book Scored ..... Date .....
Author ..... Date of Publication .....

I. CONTENT ..... (350)
1. Does subject-matter presented contribute to well-stated subject, course, and unit objectives? ..... (110)———
2. Are illustrations clear-cut, appropriate, and sufficient to make possible proper development of the unit? ..... (85)———
3. Are principles developed and illustrated by practical applications and well-chosen exercises and experiments? ..... (70)———
4. Is factual material accurately and clearly presented? ..... (85)———

II. ORGANIZATION ..... (350)
1. Is material presented on the level of achievement of the learner? (100)———
2. Is subject-matter arranged and presented in a psychological manner? ..... (100)———
3. Does author attempt early and frequently to show relation of material under treatment to human activity? ..... (80)———
4. Is material arranged in topical, or other provision made whereby pupil systematically arranges important details? ..... (50)———
5. Are summaries used as an aid to pupils? ..... (20)———

III. TEACHING AND STUDY HELPS ..... (225)
1. Does author emphasize technical words, and properly develop concepts for which such words stand? ..... (80)———
2. Is there an adequate index provided? ..... (40)———
3. Does author furnish well-chosen bibliography for each unit? .... (40)———
4. Does author furnish adequate teaching hints, helps and outlines to guide inexperienced teachers? ..... (40)———
5. Does author make available modern testing methods by listing available published tests in the field? ..... (25)———

IV. PHYSICAL MAKE-UP OF THE TEXTBOOK ..... (75)———
1. Is a good grade of white, unglazed paper used? ..... (20)———
2. Is type clear, of correct spacing, and size? ..... (25)———
3. Is binding durable, water-proofed, and artistic? ..... (20)———
4. Is the book of convenient size and shape? ..... (10)———

Total score of the book ..... ———
Name of student scoring the book .....

There is some difference of opinion as to whether a topical outline is a valuable teaching aid. Some teachers contend that it is better that the student should be encouraged to make his own topical outline. Others think it is sufficient to have such outlines ready prepared in the text. The experimaries. Such points should be considered in scoring a textbook.

The textbook, to be most useful, must be well indexed. It is not sufficient to assume that the mere presence of an index is any guarantee of its adequacy. It is necessary that one should study the care with which

the indexing has been done. This is a difficult task, and coming as it does after the labor of completion of the text itself is finished, the author is all too often content with mediocrity. Careful check should be made to ascertain the accuracy with which this portion of the work has been done.

Many authors furnish no guides, outlines or other suggestions by which the inexperienced teacher may be guided in the use of the text. Such helps may be misconstrued to involve suggestions for some one specific method best adapted to that particular text, but that is not what I have in mind. It is possible for the author to provide suggestive helps without attempting to dictate the method to be employed.

A study should also be made of the bibliography given at the close of each chapter or unit. Many authors in the past have not considered it necessary to provide a bibliography for the use of the ambitious student who would like to delve deeper into some phase or aspect of the problem. The superior student should always be encouraged to browse more widely. The text can be so constructed as to stimulate an eagerness on the part of more capable students to push on a little farther. A new biology text has just come to my desk that does this very well, while many other books leave the teacher entirely to his own devices in this regard.

The score card used in this course has been recently revised. It is presented here in its present form in Table I. Each student is given one blank score card for each textbook to be scored. The cards are turned in to the instructor as soon as completed.

In the study of general science textbooks, not only is the prospective teacher expected to score the books, but he is encouraged also to make a subject-matter analysis of at least two texts. The tabulation of these data is made to the nearest half page according as the subject-matter dealt with would most nearly place it under the following headings: astronomy, agriculture, biology and hygiene, physics, chemistry, geology and meteorology, and miscellaneous. Table II gives the averages of a number of such analyses for several of the leading textbooks. These data are discussed by the class, the advantages and disadvantages being pointed out in the course of the discussion.

Table II
Percentage Distribution of Subject-Matter in General Science Texts

Text	*Agric.*	*Physics*	*Chem.*	*Biol. Hygiene*	*Astron.*	*Geol. Meteorol.*	*Miscel.*
No. 1	3.05	45.3	6.45	29.45	3.2	1.05	11.05
No. 2	0.81	49.20	8.42	18.83	4.5	8.3	9.94
No. 3	3.3	33.35	3.45	25.20	5.75	6.85	22.15
No. 4	4.1	32.60	12.33	31.20	5.57	8.20	6.07
No. 5	4.5	39.60	6.85	26.20	7.75	10.75	4.15
No. 6	2.3	24.45	5.3	39.70	4.50	11.55	12.20

When students have turned in their score cards and the merits of the several books have been discussed, the scores are averaged in order to secure the ranking of the textbooks as judged by the students. Table III gives the averages of all score cards presented in class over a period of about four years. The rankings are a composite judgment of the class, and not my own, though in many cases I should not disagree seriously with their ranking. The divisions referred to in Table III are divisions in the score card. Division 1 is Content; 2 is Organization; 3 is Teaching and Study Helps; 4 is Physical Makeup of the Text; and 5 is Miscellaneous. The revised score card omits division 5, and distributes the 75 points for-

merly assigned to "Miscellaneous" among the items in division 3.

The chief value of this method of selection of textbooks, as I have observed it, is that it gives the prospective teacher a definite, if not objective, method of studying the main points on which it appears a textbook should be judged. He has become familiar with the merits and disadvantages of textbooks in current use. When called upon to make a recommendation as to the selection of a textbook, he can arrive at a more or less deliberate judgment, and not a mere hastily-formed opinion. I am quite certain that our plan is far from perfect. It is hoped that we may be able to minimize the element of subjectivity, but that now seems impossible. It seems certain that more interest should be aroused in the systematic study of textbooks for the purpose of ascertaining their merits. If the great organizations of science teachers, and educational administrators, should take an active interest in this problem every teacher would soon be definitely trained to do such tasks properly. It seems certain that this would raise the standard of textbooks in use.

TABLE III
SCORES ON SCIENCE TEXTBOOKS BY MAJOR DIVISIONS ON THE SCORE CARD
(Average of several classes)

Textbook	*Div. I*	*Div. II*	*Div. III*	*Div. IV*	*Div. V*	*Total*	*Rank*
Biology							
No. 1	317	300	92	73	75	857	4
No. 2	333	315	108	71	70	897	2
No. 3	333	315	82	74	71	875	3
No. 4	326	316	116	72	75	905	1
Physics							
No. 1	321	294	77	74	73	839	6
No. 2	328	316	104	73	75	896	1
No. 3	329	301	85	75	74	864	5
No. 4	297	248	45	73	66	729	7
No. 5	330	324	86	73	75	888	3
No. 6	331	314	102	73	75	895	2
No. 7	334	322	86	66	66	874	4
Chemistry							
No. 1	327	325	84	70	64	870	1
No. 2	312	289	66	74	71	812	6
No. 3	322	293	80	73	71	846	3
No. 4	321	290	77	71	70	829	5
No. 5	324	217	84	70	55	750	9
No. 6	320	227	106	72	72	797	8
No. 7	319	297	47	75	74	812	6
No. 8	326	271	100	73	70	840	4
No. 9	325	311	72	73	70	851	2
General Science							
No. 1	328	324	117	71	69	909	3
No. 2	326	311	118	73	71	899	4
No. 3	327	316	128	71	72	914	2
No. 4	311	300	130	74	75	890	5
No. 5	328	318	123	75	74	918	1
No. 6	323	305	102	71	67	868	6

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SCIENCE IN THE PROGRAM OF THE ELEMENTARY SCHOOL

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Where should science teaching begin?

"With us," say the colleges. "We have to do the work over anyhow."

"With us," says the high-school teacher. The children come to us with too much of what isn't so."

"So be it," say the elementary teachers in chorus. "We humbly acknowledge our lack of scientific information. We have had little or no science training. Our day is full of a number of things—requirements we cannot begin to meet adequately. Why one more subject? Let the high schools and the colleges do it."

But in spite of the coolness of its reception, science is edging its way into the elementary curriculum. Let us ask the university as to what it expects of science. The answer is that it is preparing specialists who must have accurate knowledge in some specific field. What does the high school say? It says that it is preparing some pupils for the university and if others care to be also present, it doesnt' object, if they don't lower the standards. Here and there a high school aims to give students, not qualifying for the university, a clearer understanding of several fields of science. Occasionally a secondary school sets up the objective of an enriched life, and this objective is one increasingly recognized, at least in theory, by the elementary school as it tries to fit the child for the life he is to live. But even in the elementary school, where sharp subject divisions still prevail, the effort is more or less of a patch work, or let us call it a mosaic. The saving feature of the situation is that the real subject of education—the child—refuses all efforts to make his education a mere building process. With him it is of necessity a growing process, and whether the teacher "integrates" or not, the child grows by means of integration. He straightaway uses the elements of the patch work and mosaic as soils from which he absorbs and assimilates, rejecting what he cannot use; and so growth takes place, frequently in spite of us and our methods.

But what is the best educational soil for the beginning of child growth? Fundamentally it is to be found in the field of individual experiences. There is where education begins. These experiences are the doorways through which we pass out into the world to possess it.

And just where are experiences obtained? In the field of nature and natural forces, on the one hand, and that of human contacts and forces on the other. Science and social studies are fundamental. They furnish first-hand experiences. Other subjects become interpreters of these experiences and weave them into an understanding personality. Thus science and social studies are basic in any rounded scheme of education.

Historically speaking, men have been slow to interpret nature intelligently. Sir Francis Bacon along about 1620 is credited with having started the thinking of the world on the right track when in his *Novum Organum* he set down the dictum that the only way to conquer nature is to obey, and that in order to obey we must study nature. Of course, the world had been curious about nature for thousands of years. The Egyptians also had evidently amassed much knowledge about natural laws. The elder Pliny made a remarkable study of natural materials as evidenced by one volume that has come down to us from the beginning of the Christian era covering some 20,000 topics. However, most of it is second-hand stuff, and fact and fancy are inextricably intermixed. Similar tendencies to mix fact and fancy are unfortunately evident today, especially in the popular press, and so, in the popular

mind. But Francis Bacon's maxim is the outstanding utterance that marked the beginning of a scientific attitude and purpose that has since given to man an increasing power over nature and natural forces.

About the same time, I don't know whether because he had heard of it or simply because similar ideas seemed to prevail about the same time in history, Galileo made some applications of Bacon's formula. He had the hardihood to question Aristotle's reasoning by which a ten-pound weight should drop ten times as fast as a one-pound weight. Much to the horror of the natives, he actually dropped two such weights from the top of the leaning tower at Pisa and they hit the ground together, thus confusing his critics, though apparently not convincing them. He made some other remarks about his direct observations of nature, these having to do with the heliocentric *versus* the geocentric movement of the solar system based on the swinging chandeliers of the cathedral. These remarks brought him the kindly attention of the Inquisition. It was one of those early battles between authority and reason based on actual experience. While authority won at the moment, as it frequently does, it was another illustration of "truth crushed to earth, *etcetera*."

The majority of the world, while it has broken loose from authority has learned very little with regard to the earmarks of scientific methods and accepts anybody's pseudo-science until somebody else comes along, as may be attested to by medical advertisements with regard to the physical life, and yellow literature with regard to the spiritual life. They use a thousand and one applications of science to the daily needs of life unquestioningly and are satisfied to be members of the dumb-bell age in which electric buttons become the substitute for an understanding mind. They have innumerable gods to worship and depend upon the Sunday paper for enlightenment and the printed instructions in the package to indicate what button to push. The scientific attitude, in so far as the public is concerned, has actually suffered because of the multitude of scientific applications to everyday life. The scientific attitude still, however, has a place in the list of objectives for the thinking world, and perhaps should head the list in so far as the teacher is concerned, except for the fact that an attitude must be more or less a by-product, and must, in turn, be measured by by-products for which we have not as yet set up appropriate tests.

While it is true that we are in the midst of a scientific age, Ptolemy's knowledge of the stars in good old Egypt would put to shame that of most of our people today who are not actually in that field of work. The habit of putting questions to nature must be cultivated. Unless one knows something about the habits of nature, he can hardly put questions to her intelligently. A growth in first-hand acquaintance with natural phenomena implies a corresponding growth of one's personality. The one who finds a familiar friend in stream and valley and mountain, in flower and tree, in plant and animal, has made his environment worth while. No one can take it from him and it becomes an integral part of a richer life and a larger self. There is probably no more soul-satisfying way of life than that opened through a first-hand acquaintance with nature. Out of it come scientists and discoverers and inventors — our Edisons, Muirs, Burroughs, Burbanks, and Jordans, and a host of lesser folk who get great joy from companionship with nature.

Agassiz has well stated the necessity of first-hand experiences as follows: "If you study nature in books when you go out of doors you cannot find her."

Science actually touches our lives, individual and community, on many sides. It reaches us through channels of health and sanitation necessary for our individual and group existence. It is concerned with the clothing we wear and the houses we build, with the food we eat, with lighting, heating, transportation, communication, and with a

thousand subdivisions of these primary protective and cooperative functions of individual and community life. But beneath and supporting this group of applications of science to life, which should be the chief concern of the junior high school, are spread the marvels of natural forces at work transforming a dead into a living planet—changing the lifeless earth into the home of man. Some knowledge and appreciation of this vast field is preliminary and essential to the most effective work in the field of junior high-school science as above outlined. It forms the primary region of discovery for the children of the elementary schools. A knowledge of this field gives to the individual the privileges of citizenship in the natural world in which he lives. Acquaintance here gives him an enriched, enlarged, and abundant life even though he be remote from the electric push buttons of civilization. It provides for him independent control of and comradeship with the natural world in which he lives.

T. H. Huxley, in 1868, gave to thinking persons certain excellent reasons why in his opinion science should be universally studied. He said,

> Suppose it were perfectly certain that the life and fortune of every one of us would, one day or other, depend upon winning or losing a game of chess. Don't you think that we should all consider it to be a primary duty to learn at least the names and moves of the pieces; to have a notion of a gambit, and a keen eye for all the means of giving and getting out of check? Do you not think we should look with a disapprobation amounting to scorn, upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?
>
> Yet it is a very plain and elementary truth, that the life, the fortune, and the happiness of every one of us, and, more or less, of those who are connected with us, do depend upon our knowledge of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. The player on the other side is hidden from us. We know that his play is always fair, just, patient. But we also know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, and one who plays ill is checkmated—without haste but without remorse.

The tentative course of study in elementary science developed in the Horace Mann Elementary School of Teachers College contributes the following with regard to the definition and function of elementary-school science:

> Unfortunately many adults think of elementary-school science as the subject-matter fields of physics and chemistry, and of nature study as that of biological science. The child is not conscious of these scientific fields, much less of their boundaries. As far as professional studies indicate at the present time, his interest is distributed among all of the major scientific fields and he needs elementary, although fundamental instruction and experience in a well balanced science program. The teacher should provide for such a program in science instead of teaching one adult-divided scientific field, such as biology, to the exclusion of all others. Science should not be separated in the elementary school. When it is so difficult for the adult to determine at what point he has passed from one field to another, it surely stands to reason that he should not differentiate between these fields to children. There has been a tendency in some schools to put biological nature study in the primary grades and physical science in the intermediate department. No valid professional study has been made to warrant this type of grade placement.

In any school system schools will vary widely as to content and method when liberty is allowed the teacher in such a subject as science.

What sort of liberty should be allowed is, of course, a legitimate question for discussion. In any event, results will depend much on the background and enthusiasm of the teacher, and upon the organization and understanding sympathy furnished by the principal. In one case improvement was evident when a small urchin reported to the principal: "We're getting our teacher really interested in nature study." One important criterion of the educational effectiveness of any teaching program is the degree to which

it functions in the children's out-of-school life. Judged by this standard, we cannot disregard the interest of pupil and teacher as most essential in determining the program. Once that is secured, the efforts of the teacher and the scant time allowed by the school program are supplemented by after school, week-ends, holidays, vacations, and the cooperation of homes and libraries. Science becomes a "way of life" to an extent seldom obtainable under the fixed course of study plan.

Under a wholly elective or incidental plan, which I am not recommending, schools in a system and the rooms in a building will vary widely, much of the work be pinched out by the more weighty "requirements" of other subjects, and efforts will fail to supplement each other, and any real program soon cease to exist. On the other hand the enforcement of a strict course of study in science is pretty certain to prove just so much dead material in the hands of the average teacher.

While sequence is desirable, consequence is of much greater import. What is so presented as to become a real part of the pupil's life and interest is of consequence to him. It is educationally of much greater moment to develop interested questioning in a worth while field and direct the effort of children in an intelligent and fruitful search for answers than to undertake to provide them with long lists of answers to questions they haven't asked. It was a Stanford professor who said he could tell the teachers in his class because they never asked any questions they didn't think they knew the answers to. Any wise teacher is ready to lead in the search for truth if she can have reasonable assurance that the search can be made intelligent and fruitful. If she has made little or no study in the field of science, she is naturally hesitant about assuming such leadership, and as has been indicated, the desired attitude is not that traditionally ascribed to the school teacher. But progressive teaching in all fields of elementary work is becoming less traditional and in the field of science the traditional methods have conspicuously failed, for the answers in the answerbook are never final and only serve to arouse more questions which have to be smothered. In the method by leadership the fringe of live and unanswered questions forms the cutting edge of progress, and is welcomed as a schoolroom situation rather than repelled.

It remains for the administration and the supervision of the work in elementary science to assist the teacher in making her efforts as intelligent and fruitful as possible. Here in Oakland we have spent much time and effort in gathering together the knowledge and experience of teaching groups to form a manual for the teacher's use. At present it has reached the stage of a mimeographed volume of 168 pages. The last third of the volume is given over to directions and suggestions for the teacher in the preparation of material and its care, devices, lists of available material, and experimental information. Fifteen pages are given to identification and feeding charts. A selected bibliography and an index of seven pages, making everything in the volume readily available, completes the work.

The first two-thirds of the volume has to do with plans of work, selection and preparation of activities and illustrative units of work. While it is not in the ordinary sense a course of study, a two-page check list of desirable knowledges to have acquired at the end of the fourth and sixth years somewhat answers the main purpose of such a course. Twenty pages are given to suggested activities and lesson helps covering an orderly progress through each of the three fields—animal, plant, and physical science.

One of the important portions of the manual is the space of forty pages given to correlations with the social studies course by grades. The science material that should aid in a better understanding of the earth as the home of man is there made available.

I have described this manual briefly in order to make clear that it is not "just another course of study" and why teachers

seemed to welcome it in a way that typical courses of study had not been welcomed. The central office further assists the teacher by means of helps in the conduct of an increasing list of excursions and an expanding list of visual material made readily available through a daily delivery service.

I note that it is one of the purposes of a national organization of science teachers to promote a "continuous and integrated science program." I see no sufficient reason for considering continuity vital in the field of elementary science. As for integration, integration that matters is more horizontal than vertical—more of a weaving together the experiences and interpretations of the day in different fields than an attempt to follow the lines of organizing principles that produce subject divisions.

Thus the only reason for regarding as essential, a course of study with definite assignments by grades, is to avoid leaving blank areas in the field of fundamental experiences, and at the same time to reduce somewhat the wide spread required of the teacher by thus sectioning the field. While both these purposes seem to me desirable, I cannot regard them as vital, or even important, as compared with fostering an attitude of sustained interest and of intelligent activity in the science field. But it is just plain good sense that a group of teachers working toward a common end should try to make their efforts cooperative and supplementary. Thus, in addition to making the science material of the manual available through complete indexing, we have charted the field of elementary science, placing on a single sheet, 20 x 36 inches, a segregated list of itemized statements adapted to each grade level with references to the manual and to a selected bibliography. The material for each grade level appears classified under four concept headings: I. The earth in relation to the surrounding universe; II. Needs of life; III. Adaptations and adjustments of animals and plants for survival; IV. Forms of matter, forces, and inventions. Thus the emphasis for each semester is indicated, but there is no prohibition on selecting material from previous portions of the field or paying reasonable attention to casual and seasonable material of immediate interest, or of making capital of the teacher's special interests and fields of experience. Within these limitations, the plan for the term's work in science is the teacher's own, subject to the endorsement of her principal. This plan is submitted to the principal at the opening of each semester and is made the subject of one meeting of teachers, either in general or by groups. Where possible, group leaders are appointed, and, in some cases, a science chairman for the entire corps.

In actual experience this plan of administering the science course of study does not produce uniform effects throughout the schools. As is the principal, so is the school. Some "haven't time" for much attention to science. Others find it furnishes valued content for other subjects—basic material for them. As a whole, the interest is growing steadily throughout the schools, and like a rolling snowball increases in its progress. Teachers are taking special courses, but their best growth takes place on the job in contact with active and curious children. The job of the central office is to keep up with the demands of the teachers, and the job of the teachers to keep up with the demands of the children. Meanwhile, the principal who sees his work organized is proud of results, and the one who lets it lag, and thus finds his school out of step, is apt to readjust his thinking. Thus our program is one of growth and development and more permanent in character than if it were imposed from above as a required course of study.

I once heard Henry Morse Stephens, of sainted memory on the campus of the University of California, define a liberal education as what is left after you have forgotten what you learned in school. He was an Englishman and this *bon mot* cleverly sets

forth the cultural ideal that has so inspired English education, and which is in no small degree to be credited with giving them leadership in the affairs of men everywhere, and which must not be overlooked in the present dominance of the immediate and practical. The American ideal seems rather to be summed up in one's knowing his way around in the world in which he lives. These two ideals of the cultural and practical do not, it seems to me, need to be mutually exclusive, but rather may be supplementary, and should rest basically on the social studies and science programs. For I think we are agreed that all external, first-hand experiences must lie either in the field of matter and material forces on the one hand or that of human contacts on the other. The combined fields of social subjects and science thus furnish the opportunity for first-hand experiences, the interpretation of which provides educational growth, and the other subjects of the curriculum are engaged in their interpretation.

FIGURE 1.—Integrating the Work in the Elementary School

I am presenting herewith a diagram indicating the relationship that should subsist between science and social studies on the one hand and the more interpretative subjects of the curriculum. Since there can be no real education without interpretation, this in no way reflects on the importance of the other subjects, but it does portray the basic character of science and social studies. This diagram is one accompanying a study here in progress, carried on by our principals.

If the scheme of science advocated in this paper is educationally sound, it calls for more than a course of study and a supervisor. It demands that the central office see to it that science along with social studies shall be regarded as so basic that every facility for promoting experiences and their interpretations in these fields shall be made available to teachers, and that faculties shall be organized so as to promote the rational and active use of these facilities.

And instead of another subject in an already crowded curriculum, with its minimum requirements and its testing program, may not science be brought into the curriculum as a way of life, furnishing a widening field of individual experiences and rational interpretations, the teaching function becoming one of leadership and the final purpose the encouragement of expanding personalities?

Are not the purposes of elementary science education herein set forth and the organization for their accomplishment in line with the best in progressive education? If so, why delay?

THE RELATIONSHIP BETWEEN THE ABILITY TO RECALL AND THE ABILITY TO INFER IN SPECIFIC LEARNING SITUATIONS

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The problem of this study finds its origin in the much discussed psychological question of the relationship between the so-called lower and higher mental processes. No attempt is made to give rigorous definitions to these terms; rather the non-technical uses of the terms are considered as sufficient. In general, psychologists identify the so-called lower mental processes with automatism, habit, and custom; while the so-called higher mental processes are identified with reasoning and thinking. The attempt is to determine the relationship which exists between certain definite aspects of the so-called lower and higher mental processes as they are exhibited in specific learning situations. This study takes the ability to recall given specific facts as one phase of the so-called lower mental processes and the ability to infer generalizations based upon given facts as one phase of the so-called higher mental processes.

Science materials are used as the specific learning situations in this study because several experts in the field of science teaching recently have emphasized certain generalizations of science as the desirable outcomes of students' science training. These experts are opposed to teaching which attempts to give the student merely items of information with no regard to the science concepts, principles, or generalizations to which such information may be related. Thus, the committee which prepared Part I of the *Thirty-First Yearbook* of the National Society for the Study of Education writes as follows:

"The principles and generalizations of science must, therefore, occupy considerable place in a program of general education, the aim of which is life enrichment. . . .

"The major generalizations and associated scientific attitudes are seen as of such importance that understandings of them are made the objectives of science teaching."[1]

The above quotations and others, which space prevents mentioning, indicate that the best and most recent opinion regarding science teaching is that students should be led to think or reason about science facts as well as be given a certain amount of specific information. Such thinking or reasoning evidently involves, in part, the drawing of inferences from given data or facts. It should be noticed here that neither psychologists nor science teachers have given a definite answer regarding the relationship between the learning processs involved in the acquiring of these two types of knowledge.

MAJOR PROBLEM

The major problem of this study, then, may be stated as follows: What is the relationship between the ability to recall and the ability to infer in specific learning situations? This investigation is not primarily concerned with current controversies over the content of any particular science course, but attempts to discover facts of value regardless of the various viewpoints on the content needs of the subject.

METHOD

Since it is desirable to measure the ability to recall and the ability to infer in as nearly identical situations as possible, it was decided to construct a series of paragraphs, each of which would give certain facts from which the desired science principles or generalizations could be inferred. In this manner these two abilities could be measured over the same material and at the same test administration.

For the purposes of the research test 30 of the 93 science principles found in 20 textbooks of general science as reported by Downing were used.[2] Special care was used in the construction of the paragraphs from which the subjects were to recall facts and from which they were to infer generalizations by applying the following criteria:

1. Each paragraph must contain a group of science facts that are pertinent to the principle which the subject is expected to infer.
2. The principle which is to be inferred must not be directly stated in the paragraph.
3. In respect to such factors as vocabulary, style, and length, the paragraph must be typical of the reading material commonly found in the general science course.
4. The paragraphs used must be new to the student; that is, they must not be exact copies of other material which he has read.

On the basis of these criteria one paragraph was made for each of the 30 science principles. Care was exercised to insure that five or more science facts which pertained to the principle to be inferred were included in each paragraph. By giving the paragraphs continuity in stating the information, it was possible to serve the purpose of the experiment and at the same time to give the paragraphs a normal appearance to the subjects.

For each paragraph two sets of test items were constructed, one designed to measure recall and the other to measure inference. Since the relationship existing between the two abilities is to be investigated, it is desirable that the two sets of items be of similar form, thereby holding constant the influence of the test form on results obtained. After considerable experimentation the multiple choice type of the objective test with five alternatives was selected. In addition to the correct choice there was always included one choice which is scientifically true but which was not given in nor could reasonably be inferred from the paragraph, and one choice of a more or less platitudinous nature.

The insertion of the choice which is scientifically true, but which was not given in the paragraph, was intended to force the subject to mark the test items on the basis of the material read, rather than on that of past experience alone. This point is essential if an accurate measure of the two abilities under investigation is to be obtained. The rather platitudinous choice was intended to attract the unthinking, uncritical subject. The success of the scheme appeared when an examination of errors made by subjects showed that the majority who made mistakes took either the platitudinous choice or the one which was scientifically true but not given in the paragraph.

The recall test for each paragraph consisted of five such multiple choice items as described above. In every case the correct choice on a recall item was an exact reproduction of a certain statement of fact given in the paragraph.

The inference test for each paragraph consisted of five statements, one of which was the correct inference; the alternatives being determined as stated above. These five statements were represented to the subject as being possible conclusions to the paragraph, from which he would be required to select the best one.

For purposes of administration, the recall and inference tests were assembled in one battery and given to the subjects as one test. To compensate for any interference effects which might result from the mere answering of the questions, the inference items were placed first on one half of the tests and the recall items first on the other half. The tests were given in such a way that the subjects could not see both a paragraph and the questions on it at the same time, nor could be turn back to a given paragraph after having started to answer the questions on it.

Complete returns from the tests were obtained from 324 students, 184 boys and 140 girls, who were regularly enrolled in the general science courses in Southwest High School, Kansas City, Missouri, and Jefferson Junior High School, Columbia, Missouri. The mean intelligence quotient for the 324 subjects as determined by the Terman Group Test of Mental Ability was 107.9 and the standard deviation was 14.3. The mean chronological age was 14 years and 2 months.

RESULTS

The results from the research test show certain significant differences between the ability to recall and the ability to infer in the specific science situations employed. Analysis of test results by means of coefficients of correlation show a positive relationship between the two abilities, but also demonstrate that the two abilities are different. Space does not permit the presentation of the detailed results from these coefficients but let it be sufficient to say that no statistical measure of relationship could be found which would guarantee the sameness, or near sameness, of these two abilities.

Sex differences were found on the inference section of the research test. The comparison of mean performance of boys with that of girls in the light of the standard errors of the means showed 999 chances in 1000 that a true difference greater than zero exists in favor of the boys. No reliable sex differences were found in results from the recall section or from the Terman Group Test of Mental Ability.

There were several indications that the subjects had more difficulty in inferring science principles than in recalling the given science facts. The distribution of scores from the inference section was noticeably skewed toward the lower end of the scale while scores from the mental test and the recall section of the research test each showed nearly normal distributions. The coefficients of variability showed the subjects to be over one and one-half times more variable on inference than either recall or intelligence.

The lowest one-fourth in intelligence experienced extreme difficulty in reacting to the inference section; their mean score being only slightly more than that which might have been expected from chance alone. Such was not the case on the recall section. On inference the lowest one-fourth in intelligence show much less consistency in performance than those of higher intelligence while just the opposite situation exists for recall.

An analysis of the number of correct responses to each item in the research test showed practically zero correlation between percentage of correct responses on recall and the percentage of correct responses for the corresponding items on inference. No relationship could be found between the difficulty of those items designed to measure recall of given facts and the difficulty of the items designed to measure the ability to make an inference from the same facts.

To determine the relative contribution to performance in general science indicated by the scores on the Terman Group Test of Mental Ability, the recall section, and the inference section of the research test, a regression equation was derived in which these three test scores were used to predict teachers' marks in general science. This equation indicates that in the prediction of marks the scores on the recall section have about three-fourths as much weight as the Terman Mental Test, and that the scores on the inference section have about eleven times as much weight as the Terman Test. The scores on the inference section have about fifteen times as much weight as those on the recall section. By using a special form of the regression equation in which standard deviations are equated to

give the relative contributions of the three abilities measured to the ability to get teachers' marks, it was shown that the ability to infer is about three times as important as the ability to score correctly on the Terman Mental Test.

When we combine the significance of the ability to infer in the ability to get marks in general science with the clear cut evidence that at least one-fourth of the subjects were practically unable to perform on the inference test with any degree of accuracy, it is clear that the teachers are attempting to mark many of the students upon an ability which the students cannot successfully perform. It is also evident that the teachers consider the ability to infer an an important outcome of science training. These facts probably account for a fair portion of the variability of teachers marks.

In view of the facts that the generalizations used in this investigation are those selected from general science textbooks and that the instruction the subjects had received was given by highly trained and experienced teachers, it is not too much to suggest the probability that many of the generalizations contained in the textbooks are beyond the comprehension of from one-fourth to one-half of those students for whom the texts are intended.

Certainly it is clear that there is need for investigations of the relative difficulty of the major generalizations of science and associated attitudes which are expected as student outcomes. Methods of teaching designed to establish efficiently those understandings which are within the abilities of the students should be determined.

The evidence that the ability to recall and the ability to infer in specific science situations are different abilities indicates that it is not sufficient to teach facts with little or no suggestion of their relationships to major science generalizations. Likewise, it is not sufficient to concentrate instruction solely on the generalizations. Both facts and generalized ideas must be taught in their relationship to each other.

SUMMARY

1. The ability to recall specific facts and the ability to infer a generalized idea from given facts or data are considered to be phases of the so-called lower and higher mental processes, respectively.

2. Science situations are used because of the recent emphasis on major science generalizations as desirable student outcomes of science training.

3. Three hundred twenty-four students regularly enrolled in general science courses represented the subjects for this investigation.

4. The ability to recall and the ability to infer are different abilities.

5. Boys are superior to girls in the ability to infer. No sex differences were found for the ability to recall or for intelligence.

6. The ability to infer is a more difficult process than the ability to recall.

7. The lowest one-fourth in intelligence are for practical purposes unable to do inference of the type commonly demanded in the general science course.

8. The ability to infer, the ability to recall, and the ability to score correctly on the Terman Group Test of Mental Ability enter into the ability to get teachers' marks in general science in the ratio 3 : 1 : 2.

9. Teachers are attempting to mark students on the ability to infer when many of the students cannot successfully perform in this ability, hence a partial cause for the variability of teachers' marks.

10. Investigation is needed to determine those generalized science ideas which are within the comprehension of students who normally take the science course and to establish efficient methods of teaching for understandings of the generalizations.

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SCIENCE CLUBS IN RELATION TO STATE ACADEMIES OF SCIENCE

S. W. Bilsing

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The State and Regional Academies of Science from the nature of their organization and because of the great diversity of the scientific interests of their members should constitute the chief agency in coördinating the activities of the science clubs in their respective localities. Science clubs have a variety of objectives. On that account it is not possible to classify them in any definite way. For the purpose of this discussion they may be considered as belonging to one of two general groups: (1) those which are composed of adults only and (2) those organized for the benefit of pupils in the public schools.

The objective of the first type of science club is usually indicated by its name, such as the Tennessee Ornithological Society, the Barnard Astronomical Society, and the Texas Archaeological and Paleontological Society. School science clubs are usually composed of the pupils who are pursuing science courses in the public schools but some of them have, in addition, honorary members and alumni members. If all of those who are interested in these various types of science clubs could be aligned in one central organization, a great deal of progress should be made in furthering scientific ideals and in the promotion of projects of statewide interest such as reforestation, soil conservation, preservation of wild life, conservation of natural resources and natural history surveys. For several years it has been the ambition of the members of some of the State Academies to inaugurate a plan by means of which these science clubs could be united into a closer confederation.

It is the purpose, as well as the function, of the State Academies of Science to foster research and spread scientific knowledge. In the past perhaps too much attention has been given to the exchange of information between groups of scientists engaged in limited fields and too little attention given to extending scientific information as a whole to the "lower levels." Most State Academies in the past have expended the greater amount of their resources in grants to research and in the publications of their transactions. Aid has also been given to the publication of scientific papers by members of the academies. Such types of activity should certainly be their main objectives. State Academies of Science should also consider methods of carrying scientific knowledge to the general public. This should be done first of all to acquaint the general public with the value of science in

every-day living and also to acquaint a larger group of people with the ideals of scientific thinking. Scientific work cannot be carried on unless it receives a certain amount of support, and unless the public is informed of the value of this work, adequate support is not likely to be provided. In times of financial stress this work may be curtailed when it is most needed.

Scientists as a group have not convinced the general public of their usefulness. True it is that most people realize the value of the work of such outstanding men as Edison and Steinmetz but the public as a whole does not realize the value to society of the work of those who do not have the ability to make the great contributions. That the value of scientific work has not penetrated far into the thinking of the mass of people is evidenced by the attitude of our legislatures in reducing appropriations and in cutting out grants for research; and by that of the press in blaming the economic situation upon the efficiency of the methods which scientists have developed.

The public has not been apprised of the fact that many discoveries of a lesser nature are constantly being made and that all of these together improve our methods of living. In the past the lack of coordination of efforts and of sufficient prestige has kept us from accomplishing many things which should have made life more worth while both to ourselves and to posterity. On that account our natural resources have both been wasted and diverted to the use of a favored few instead of being used to enrich life for the whole commonwealth. All of these facts lead us to the conclusion that we must develop some system for the better coordinating of our efforts and for enlisting the support of the public in consumating them.

Some State Academies have done a great deal to coordinate the effort of their investigators and teachers, and the results they have achieved should stimulate the rest to increase their efforts to attain equal accomplishments. The Illinois Academy has affiliated with it 45 scientific organizations together with 87 high-school science clubs. This spirit of coordination seems to be largely responsible for the service which is being rendered the whole state by the Illinois Academy, which has been the leader in such state-wide projects as sewage disposal in the large centers of population and the reforestation and soil conservation of the Ozark region in the southern part of the state.

The St. Louis Academy has interested the public in the metropolitan area of the city in public lectures on scientific subjects by having several public lectures each year, at which the average attendance is more than a thousand people. The Ohio Academy has assembled a library at the State University which is of so much value that the State University is willing to provide space, have the publications cared for by one of its own librarians, and bear the expense of mailing the publications, as well as making a substantial contribution toward the cost of printing the Ohio Journal of Science. Other academies have done many worthwhile things but there is still opportunity for further accomplishments.

Two plans have been developed by a few State Academies in an attempt to coordinate the scientific work being carried on and to enlist the interest of a larger number in the development of scientific work for the future.

The first of these plans is to affiliate science clubs already organized and to organize science clubs in new localities. Such a plan is being inaugurated by the Texas Academy in an effort to enlist the interest of the science teachers in the colleges and high schools and to further the work of the Academy among people who are interested in science but engage in professions other than research and teach-

ing. Each science club elects a delegate to a State Academy Conference, which is composed of one delegate from each affiliated organization. The delegates from the affiliated science clubs hold a meeting and dinner at the time and in connection with the annual Academy meeting, at which each has an opportunity to discuss topics of importance to the advancement of the Academy as a whole and also those topics which are of especial importance to their own organizations. It is hoped by this method of stimulating local clubs that something may be done toward spreading science in the local community. Perhaps later it will be possible through these clubs to arrange lectures for the general public. It may be possible for State Academies to provide a list of speakers from their members who can speak entertainingly and effectively to these affiliated clubs on their special fields of science. This not only would add inspiration but also aid in establishing a fine relationship between these clubs and the State Academies.

The second plan and the one which has received the most attention is the Junior Academy of Science movement. This is the name which has been applied to the relationships between the school science clubs and the state Academies of Science. The plan of affiliating school science clubs with the State Academy of Science originated with the Illinois Academy in 1919. In that year J. L. Pricer, Secretary of the Illinois Academy, recommended that there should be a permanent committee on science education in the secondary schools.

During the first year four high-school science clubs affiliated with the Illinois Academy. During the first ten years of its existence many difficulties were encountered in keeping this work alive; however, the interest has gradually increased until at the present time there are more than eighty school science clubs affiliated with the Illinois Academy of Science. The State Academies of Indiana, Iowa, Kansas, West Virginia, Pennsylvania, Alabama, and Texas either have the plan well under way or have inaugurated it recently.

The Junior Academy movement offers a fine opportunity to the State Academies to carry the value of scientific work to all parts of the state. It also offers an opportunity to interest students in secondary schools both in scientific pursuits and in cultivating a sympathetic attitude toward scientific work. Only a small per cent of students in secondary schools have the opportunity of attending colleges. The Junior Academy of Science should be the means of creating and cultivating an interest in scientific work among those who will never be able to avail themselves of this opportunity. If their interests are sufficiently aroused as students, some of them, no doubt, will be interested in these clubs as alumni members. The continued interest and influence of these alumni members will have a great deal to do with maintaining the interest of school science clubs.

More than the stimulation of science clubs should be the objective of creating in the student himself an interest which will be continued after he leaves the school. In other words, the creation of the scientific ideal of seeking after truth should be the main objective in fostering school science clubs. If these science clubs can inculcate in the individual the ability to use his mind in analyzing a situation and arriving at the truth about conditions they will have served a most important office in building a better community. Another objective should be the discovery and developing of those who are best adapted to become the leaders in scientific work in the future. One needs but to read the lives of our great scientists of the past to learn that many of them made great contributions because they were influenced by the ideal of some great teacher, either through direct contact or by reading about his accomplishments.

The influence of the Senior Academy

should have much to do in shaping the idea of what constitutes a science club. The central idea should be that of developing in its members the ability to think clearly and to properly evaluate the problems of life. The effects of the study of science should be carried into other fields than those of science if we are to progress in the right directions in the future. The scientific attitude is needed by society and there seems no better place to develop this than through the school science clubs. "Finer attitudes" of mind, "Better habits" of thinking, and the proper adjustment of these attitudes to the present-day world should be the objectives of these clubs. Manifestly it is not practicable for the State Academy to determine exactly what shall be the nature of science clubs but by proper influences in the form of programs, lectures, radio programs, etc., a wide interest may be created among the members of these clubs. Science clubs which tend to specialized subjects have usually been short-lived. Several State Academies during the past year have sponsored radio programs and one Academy at least (Iowa Academy) has sponsored a radio program especially for the benefit of the Junior Academy of Science. This is one of the agencies for developing a well-rounded idea of scientific interests. To emphasize some particular field of science is to establish a system of thinking which is at variance with the purpose of the clubs themselves. It should be the aim to foster an attitude which will explore the various realms of scientific experience and thought with a view of enriching the individual, who in turn adds to the enrichment of life in the home, the community, and the state.

State Academies can render an important service in promoting these ideals by selecting Junior Academy leaders who possess the qualities of character, leadership, and devotion to ideals which is necessary for the promotion of the Junior Academy work along these lines.

It is to be hoped that State Academies may work out a plan whereby Junior Academy leaders can devote a great deal of their time to the stimulation of the work of these school science clubs. Perhaps in time state aid can be secured in some states, as has already been done for maintaining libraries and publishing transactions, so that the Junior Academy leaders may devote part of their time to this work and still retain a connection with their special field of science. It may be possible to secure endowment funds to promote this type of work after it has grown sufficiently and its leaders have demonstrated its usefulness to society. In the meantime it will be necessary for other members of the State Academies to assist the Junior Academy leaders by making contacts with school science clubs, by giving lectures, by furnishing slides and moving pictures, by aiding in the preparation of programs and furnishing lists of references suitable for use in preparing programs. Scientists in particular fields of study can furnish the Junior Academy leader with mimeographed copies of the biographies and accomplishments of some of the great scientists in their particular field when such information is not available in public libraries. Members of other affiliated bodies of the State Academies should prove useful to the Junior Academy leader in aiding him in developing programs and making exhibits, because in most cases they are interested in some particular field of science. Inspiration and interest should be created by an occasional joint program between the adult science clubs and the school science clubs. Especially this should be true in relation to field trips. Next to the school sponsor the Junior Academy leader is responsible for the creation of the right type of ideals in the school science clubs. He should be intensely interested in science himself, be possessed of qualities of organization and leadership, be capable of making contacts with school administrators and

club sponsors, and yet not seem to be injecting his own individuality into the work.

Along with the Junior Academy leader, the club sponsor shares the responsibility of maintaining and developing interest in this work. Those who have made surveys of school science clubs have found that the success or failure of school science clubs depends in a great measure on the interest of the club sponsor. If a club sponsor changes positions, often the new teacher lacks interest and the club dies. The inspiration furnished by the Junior Academy of Science should help in remedying this condition. The annual meeting of the Junior Academy with the Senior Academy should inspire club members who serve as delegates so that they will not allow a club to die even though the science teacher is not interested. By working through state and local teachers' organizations Junior Academy leaders may find it possible to organize the club sponsors and affiliate their organization with the State Academies. It has been found that the problem can be attacked through the organizations of science teachers in the State Teachers Association. The club sponsor must also possess the qualities of character and leadership which are necessary in the Junior Academy leaders.

One of the problems to be solved is to interest the teachers of science themselves in the activities of the State Academies and also to develop conditions which will make it necessary to employ teachers who have had an adequate science training themselves. Teachers are often employed who have not had sufficient scientific training to be in sympathy with scientific ideals. It is not enough for teachers to have been trained in a teachers college in the methods of teaching science; they must also acquire an intimate knowledge of science itself. Sometimes there has been too wide a gap between the teachers of science in our colleges and those in the high schools and grade schools. Scientists teaching in college and doing research work too often have been so occupied with their activities that they have not taken the time to lend the inspiration they may have been able to give to teachers in the schools. On the other hand teachers of science in the schools have held aloof many times from receiving any aid from teachers and research workers in the colleges. If the school science clubs are to function in the proper way the teachers of science must be able to furnish much of the inspiration. The State Academies should try to promote conditions which will make it necessary to have that type of teacher.

The support of school administrators is essential to the proper development and maintenance of school science clubs. It is an encouraging fact that some school administrators will not employ teachers who are not interested in this type of extra-curricular activity. A great deal of good can be accomplished through state and national teachers organizations by bringing to the attention of the these men the value of this work in developing and enlisting the qualities of leadership which otherwise might be expended in unsocial activities. The meetings of science clubs should not be held at times when pupils are tired or late in the afternoon. The interest of the school administrators will aid a great deal in having these programs at a time of the day when the club members will receive the most value from them.

The State Academies can furnish inspiration to the school science clubs by making the Junior Academy programs at the annual meeting one of the important parts of the academy meeting. The Junior Academy program should be scheduled at a time when other programs will not detract from the interest in it. The delegates who attend these meetings and carry their enthusiasm back to the other members of the clubs will do a great deal to

help in increasing the momentum that affiliation with the Senior Academy should initiate.

Lastly, we should not forget that although science has done a great deal in the past two or three hundred years for the enrichment of human life, yet many human beings are still living in misery. Scientific discovery has added to the comforts of life; yet the value of life cannot be measured by material benefits. Science has been instrumental in making this a great and prosperous nation but if its scientists fail to promote a philosophy which provides for the enrichment of the life of the individual, the evaluation of life itself and the proper attitude of the individual to his surroundings, in the end scientific discovery may only be an aid to the destruction of the materialistic civilization it has created. It has been estimated that there are about 4,000,000 pupils in our schools who are eligible to join these school science clubs. Constructive effort in an attempt to coordinate the work of these clubs with the State Academies offers an opportunity to work toward the attainment of this goal.

RADIO LESSONS IN ELEMENTARY SCIENCE*

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Although we may not realize it, most of us learn certain things by listening to the radio. The news events of the day are digested for us in a few minutes. And whether we like it or not we become familiar with the latest in jazz. The radio has accomplished more perhaps than any other invention toward annihilating distances. It has in reality brought the world to our ears. Radio not only widens our horizon, but it multiplies our experiences. It gives us a thrill and feeling of participation in such interesting events as the inauguration of the President of the United States, or of King George opening Parliament, or of following Byrd to the South Pole.

So if the radio is a means for the dissemination of information why shouldn't we make use of it in our schools? Well, there are different points of view in answer to this question. There are those who think of the radio as a nuisance and that it has no place in the schoolroom. Another group anticipates that it will revolutionize education, while others conceive it to be one more effective educational tool. Some of these must be mistaken and time will reveal who is correct in his thinking.

It is my belief that the radio can be a very effective tool in teaching, but because it is a new tool we do not know how to use it skillfully. Most of us are afraid of it and are timid at the microphone. But it seems the only way to learn how to use the radio as a tool in the teaching-learning process is to experiment with it. Any progress will be over that hard road of trial and error.

We are in this experimental stage of trying to teach elementary science to pupils in the sixth grade in Cleveland. Seventy-two schools, involving approximately one hundred classes, are participating. In other words, about 4000 sixth grade pupils receive a radio lesson in science every Monday morning at 9:30. These are broadcast from the WTAM studios. Hence from the physical standpoint—the day, the time of day and the ease in getting WTAM on the radio receiving set—the set-up is ideal.

Most of the lessons coincide with our course of study. This is one factor in the success of radio in the school, for radio lessons seem to be far more effective if they are made an integral part of the school sub-

* Resumé of address given at the Meeting of the American Nature Study Society, Boston, December 27, 1933.

ject. The radio lessons progress just as we think an average class can progress. Although each lesson is on a new topic or phase of the unit, there is a thread of continuity running through that makes for a unified, coordinated course.

The broadcast is 15 minutes in length, and since the time allotment for science in the sixth grade is 120 minutes per week, we assume that the radio lessons are teaching one-eighth of the course to one hundred classes. We have attempted to make them just as natural as if they were being given right in the school room and have avoided the dramatic or spectacular.

RADIO AIDS IN THE LEARNING PROCESS

We school people cannot afford to overlook a fundamental element in the radio lesson, in that it is an important factor in learning. The elimination of all extraneous sounds and interferences makes for a high degree of concentration. The attention,—the whole being is focused on the lesson. And the science lessons are not conducive to passive attention, for they combine seeing, hearing, action, and participation.

Unquestionably the radio is bringing a new appreciation of hearing. We know the child learns much from the world during the years before he enters school and before he learns to read. He learns by hearing and by looking at things. Yet in school we have made the printed page the chief source of learning, although we know there are many pupils who have difficulty in reading.

ADVANTAGES TO SUPERVISION

The radio is especially effective as an instrument of supervision. It enables supervision to really be cooperative. For example, it gives me an opportunity to say to 72 schools, "I'll be over Monday morning to teach your science." It therefore divides the responsibility of teaching between the classroom teacher and the supervisor.

Perhaps the chief service of the radio lesson is to multiply good teaching. Although our science radio lessons are far from perfect, they give teachers many ideas of teaching situations. Since the teacher is an active part of these lessons, it will be much easier for her to continue to use this type of lesson than if she were merely an observer. Because so many different techniques are used in the radio lessons, the teacher will not be apt to imitate one method, but will adapt several methods to meet her needs. Lessons that move toward a definite goal are demonstrated as well as what may be accomplished in 15 minutes if everything has been planned and all material is organized.

I do not believe it an exaggeration to say in closing that if the radio lessons are dynamic and forceful they greatly stimulate and accelerate the teaching-learning process.

TEACHING AIDS IN SCIENCE

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Among the problems that confront the science teacher of today is the one of apparatus necessary to carry out the numerous demonstrations suggested in the textbook and laboratory manual. This is particularly true of the smaller secondary schools located in communities where the science department is fortunate to have a room or two with very little equipment. Since the secondary school in the United States is still predominantly rural rather than urban, this constitutes a problem of considerable import to those delegated to teach science in such schools.

To carry out many of the demonstrations suggested for the course usually requires the use of apparatus that is not available. This results in "textbook"

teaching." The pupils "learn" the demonstrations and if their lesson is well done, they are able to recite the next day on what would or should happen if a certain demonstration were to be performed. The teacher and the class both become conditioned to this type of performance and the chances are that even the experiments for which apparatus is available will be taught in the same way. Such science teaching would be a travesty in this, an age of science.

The question as to what can be done for these people arises. Teachers in general can be divided into two classes; there are those who willingly accept and experiment with new teaching devices, methods and ideas and those who are content to go along from day to day using only those methods and ideas which they have used in the past. For the former a number of things might be suggested toward the solution of the problem; as to the latter, little can be done.

Since apparatus of some kind is necessary for all demonstrations in science, one way of overcoming the difficulty is by home-made apparatus. Any teacher who has tried his hand at it has found that it is comparatively easy to construct useful demonstration items out of simple materials found right in the school or easily obtained from the outside. In addition, it is not necessary for the teacher to be expert at carpentry, soldering, etc. All that is required in this connection is the willingness to use a few of the simplest tools, such as the saw, hammer, pliers and screwdriver.

It is with the above principles in mind that the following home-made devices are suggested. They have been used successfully in science classes and in every case have taken the place of pieces of apparatus that the average or small school cannot afford. No attempt will be made to classify them according to subjects as there is, for example, quite an overlapping between general science, physics and chemistry.

THE DAVY SAFETY LAMP

A suitable device for showing the principle of the Davy safety lamp can be made from two pieces of wire gauze such as is used in the laboratory with Bunsen burners. Shape such a piece of wire gauze on a broom handle so that it will have the form of a cylinder and stitch the ends where they meet with fine copper or iron wire to keep the gauze in this shape. With a tinshears, cut a circular piece of gauze out of the second piece, about 1½ inches in diameter. Stitch this as a top to the cylinder, and the safety lamp is complete. This device, shown in Figure 1, will enable one to illustrate the principle of the Davy safety lamp. This is done as follows: Light a short piece of candle and place the gauze lamp over it. It will continue to

FIGURE 1.—Davy Safety Lamp

burn unchanged. Direct a stream of *unlighted* illuminating gas into the side of the lamp, so that the gas strikes the flame of the candle. The gas will ignite and burn on the inside but will not strike back and light on the outside. The conductivity of the gauze is sufficient to remove the heat produced within the lamp and thus keeps the temperature of the gas below its kindling point. When the gauze gets red-hot, the flame passes through the gauze and ignites the gas on the outside. For schools that do not have illuminating gas, hydrogen could be generated in a small bottle and used in a similar way.

THE DENSITY BALL

The "density ball" is used to illustrate two principles: (1) that "floating" is a relative term and (2) that the density of water varies with the temperature. It usually consists of a hollow brass ball containing some lead shot, so constructed that it will float in cold water and sink in warm water.

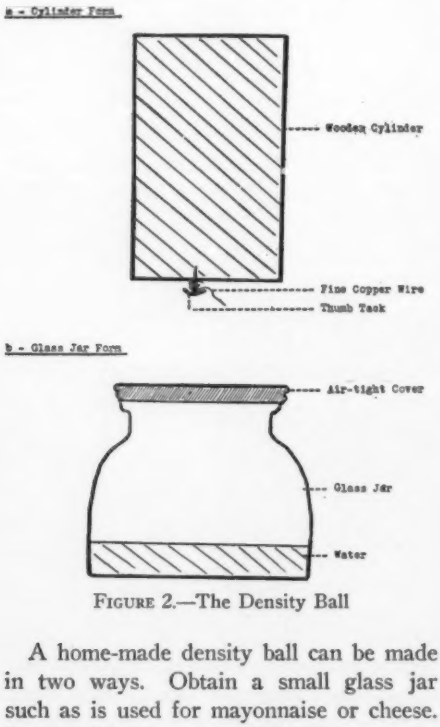

FIGURE 2.—The Density Ball

A home-made density ball can be made in two ways. Obtain a small glass jar such as is used for mayonnaise or cheese. It should have an air-tight cover. Put a small amount of water into the jar and close the cover tightly. Place it in a battery jar of water and note whether it floats or sinks. If it floats, keep adding small quantities of water until the jar just submerges. By varying the amount of water in this manner, it is possible to adjust it so that the jar will sink in warm and float in cold water. (See Figure 2.)

Another way to make a density ball is to use a wooden weighted cylinder such as is employed in the experiment on the Law of Floatation. Wind 6 or 8 turns of fine, bare copper wire on the stem of a thumb-tack and insert the latter in the lower end of the wooden cylinder. As the latter by construction has a density nearly equal to that of water, it is a fairly easy matter to obtain the proper density for warm and cold water by cutting small pieces of wire off the thumb-tack. To avoid absorption of water by the cylinder, it should have a coating of paraffin. Then, once adjusted, it can be used whenever occasion arises.

Sometimes the regular brass density ball becomes slightly dented due to careless handling or dropping. This renders it useless for the purpose of this demonstration. This can be overcome by placing the ball in a dish of molten paraffin and giving it several coats of paraffin depending on the size of the dent. By trying it in a jar of water after each coat, a point will be found where it will function as well as when it was new.

THE WATER LENS

A "water-lens" can be made as follows: Place face to face, two 3-inch watch glasses, with a piece of wood the thickness of a toothpick between them *at one point*. Heat some sealing wax in a shallow pan to a little above the melting point. Dip the rim of the watch glasses in the wax a little at a time and allow it to cool after each dipping, until only a small opening remains at the point kept open by the splinter. When the rim has cooled sufficiently remove the splinter and force water into the opening until the hollow space within the glass is full. Then seal this opening with a bit of wax, making it air-tight. (Figure 3.)

To show the properties of such a lens, it can be used as a reading glass or to magnify objects. The magnification factor will run between 2 and 4 depending on the size and curvature of the watch glasses.

The lens can also be used to focus the rays of the sun to ignite a match, cigarette or a piece of cloth. In order to prove that it is the *water within* the watch glasses that produced these effects, a similar pair of

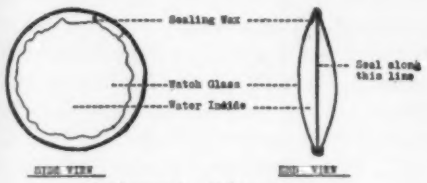

FIGURE 3.—Water Lens

watch glasses without water can be set up. It will be found that none of the effects recorded will take place.

This water lens can also be used to take pictures in place of the regular glass lens of a camera. It is most easily adapted to a Graflex camera but since few schools have them, a kodak or box camera have to be used. With a little ingenuity, a teacher could apply the water lens to either of these, and could obtain pictures equally as good.

Should a teacher feel that there is no time available for carrying out the above suggestions, they could be turned over to members of the class as projects. None of them require anything but the simplest of materials available in any school. Little time is required for their construction and no technical operation is involved. The interest aroused and developed in any class by such devices will more than repay any teacher for undertaking them.

A PROPHYLAXIS FOR EMOTIONAL THINKING

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Our smug satisfaction with the results produced by our educational system receives a terrible jolt when we learn that the people of the United States spend $350,000,000 a year for "patent medicine" and $125,000,000 a year for the service of cultists and other irregular practitioners of medicine who have never studied the human body and do not understand its working. It receives another jolt when we learn that a small group of extremists such as the anti-vivisectionists and similar organizations can influence legislative bodies and fool school officials.

It would be a utopian vision to pretend that adequate courses in physiology and hygiene could completely wipe out such stupidity and completely annihilate the pernicious activities of the enemies of society. It would be a far greater mistake however, to presume that the school cannot play an important rôle in directing the thinking of children on such topics into healthy channels, or that the school cannot furnish a prophylaxis for emotional thinking.

Perhaps a few words in regard to the relationship between emotion and intelligence will make the necessity for a prophylaxis for emotional thinking more evident.

Emotion came into the world long before intelligence. We may for the purpose of this discussion then consider the mind as a partnership—Emotion & Intelligence Co.—of which emotion is the senior member of the firm. How quickly the firm goes into bankruptcy, when, as frequently happens in business, the senior member reduces the junior member to a mere figurehead. When we feel strongly, it is difficult to think clearly; our feelings sometimes become so strong that it is necessary to postpone our thinking process until our feelings have subsided.

Man's hope lies in the use of his intelli-

gence. His adaptations made on that basis are far superior than those made on the basis of feeling. In fact, his feelings are unreasonable and unreliable. Why then do so many people make their adaptations on the basis of their feelings? Because it requires less effort to feel than to think.

We thus have an explanation for the activities of cultists and other irregular practitioners of medicine, as well as their clients; of a small group of extremists,—the antivaccinationists; of the activities of a group of misguided sentimentalists—the antivivisectionists.

It is not intended to convey the idea that all members of the above-named groups are unintelligent; many of them have intelligence but they make their adaptation on the basis of their feeling; they rationalize, *i.e.*, they find a reason to support their feelings, whether such reason be true or not. Ask an antivaccinationist why he is opposed to vaccination, and you will find that he "just doesn't believe in it;" that his adaptation is made on the basis of feeling; the world of reality brings to him no message.

Ask an antivivisectionist why he is opposed to animal experimentation and you will find that his opposition is based upon temperamental bias, or accidental prejudice, rather than clear vision of fundamental principles.

The explanation that people make for patronizing cultists and other irregular practitioners of medicine, shows clearly that they are making adaptation on a lower level than intelligence. The same statement holds true with reference to patent medicine addicts.

The schools can and must play an immense part in directing the thinking of children into proper channels. They can and must play an important rôle in combatting the pernicious activities of a group of misguided sentimentalists who in the name of mercy would condemn future generations yet unborn to remain helpless victims of biological ignorance. This is so obvious that it almost seems necessary to apologize for mentioning it. And yet, this phase of education receives little or no attention in our public high schools. I might cite, as an illustration, that according to one outline in science that I have before me, children in the ninth grade are not even to know that there is such a thing as a nervous system, to say nothing of giving adequate instruction as to its function and hygiene. According to the outline, germ diseases are not to be discussed.

The best prophylaxis for emotional thinking on such topics as I have discussed above, are *the principles and facts of biology.*

The first question then that confronts the teacher of biology is what are some of the principles of biology? One principle that has a bearing on the subject is that *micro-organisms are the immediate causes of most diseases.*

The second question that confronts the teacher is, what is the best way of making these principles a part of the individual's mental equipment? Certainly not by copying them out of a textbook and memorizing them. How some of the biological facts and principles were taught to the ninth grade pupils in the Lake View High School will be discussed in the following paragraphs.

Practically all of the pupils had heard of germs and germ diseases, but none had ever seen germs or had proof that they cause disease. It isn't necessary to explain in detail how bacteria were gotten from the air and how they developed colonies; every teacher of biology is familiar with the method. When microscopic slides were prepared from the deep golden colonies and pupils examined them with the microscope, they saw germs for the first time, the staphylococcus type. What a revelation it was to them to see the actual germs that the text had described as causing boils and carbuncles. Their belief that germs cause disease was

pretty firmly established when pus from a boil that a pupil had on his neck developed in agar media golden colonies of germs—germs which when examined with the microscope they found to be the staphylococcus type.

To show the pupils that certain germs give off a poison that destroys blood cells by dissolving them, a few members of the class were asked to swab their throat and touch the swab to blood agar; after a few days the agar was examined and it was found that hemolysis had taken place. Furthermore, examination with the microscope proved that the germs were the streptococcus type.

After having studied a few of the more or less common type of bacteria, arrangements were made with the bacteriology department of the University of Chicago whereby the pupils could see the work in bacteriology conducted on a large and thoroughly scientific scale. They not only saw other types of bacteria that were only briefly discussed in the class, but they saw what effect these organisms had on susceptible lower animals that had been inoculated with them. They also got some idea of the great service the bacteriologist is rendering to humanity.

The rôle that the bacteriologist plays in protecting the health of the people of a large city, was brought home to them in a most forceful manner when they visited the headquarters of the Chicago Board of Health. Here, in one room they saw bacteriologists testing (for purity) the city's drinking water; in another room milk was being examined; in a third room microscopic slides were being prepared and examined, from cultures that had been sent to the Health Department.

After the pupils had visited the laboratories, the Health Commissioner in his address pointed out to them the importance of vaccinating against various diseases; he particularly stressed early immunization against diphtheria. He showed them how the schools in cooperating with the Health Department, this disease could practically be wiped out. That these suggestions did not fall upon deaf ears, *i.e.*, that these pupils were instrumental in immunizing hundreds of children in the community against diphtheria, I have conclusive evidence.

It is safe to say that children who are taught the biological principles as suggested above, will not be misled by the silly arguments of the antivaccinationists.

Another biological principle that has a bearing on emotional thinking and should be taught to pupils not later than the ninth year is that *the functions carried on by the body are for the most part directly or indirectly carried on by the nervous system.*

The pupil who really learns the above-named principle is not likely to be misled by the false statements of the irregular practitioners of medicine or the pernicious activities of the antivivisectionist. (In this connection I wish to call the reader's attention to that splendid article by Cannon, "Enemies of Society," found in *Scientific Monthly*, 36, pp. 150–164, Feb., 1933.)

To attempt, however, to teach this principle, without using any illustrative material, would be as absurd as for a chemistry teacher to try to teach chemistry without test tubes and reagents. When the pupils read in their texts that a frog with its head cut off, swims in the most natural manner; or when a drog of vinegar is put on the back of a brainless frog, the frog will wipe the vinegar off with its foot, they want such statements verified by experiment. When they read, or are told that the heart of a turtle will continue to beat for a day when severed from its body, they want to be shown.

A few other experiments that should be demonstrated to pupils in connection with this biological principle might be mentioned: stimulation of the vagus nerve; stimulation of the sciatic and femural nerves; a comparison of ethylene with ether as an anæsthetic.

To satisfy the pupil's desire to have state-

ments verified by experiments, arrangements were made with two leading research workers in physiology in this country—A. J. Carlson and A. B. Luckhardt of the University of Chicago, to perform not only those experiments described in their school text but experiments of a somewhat more advanced type.

After the pupils had seen the experiments with the decapitated frogs, turtles, etc., they were told by the research worker himself, the developer of ethylene, how the anæsthetic properties of ethylene had been discovered; how it was first tested on lower animals, frogs, mice, rats, cats, dogs, and finally on human beings.

So favorably were these freshmen impressed with the experiments and lectures and so urgent was the request for more work of this kind, that I made arrangements with another research worker of national prominence—A. C. Ivy, of the Northwestern University Medical School, to perform for them some additional experiments along the same line. These experiments and lectures given by Ivy and his co-workers, were so interesting that they held the pupils spellbound for almost two hours.

That these young people, when they are adults, will not be found in the camp of a group of misguided sentimentalists, can be reasonably assured.

In closing, may I express the sincere hope that these few pages have at times brought to the mental centenarian school officials, who would keep children in ignorance, deep and lasting pain, for the keenest pain known to human nature is the pain of a new idea.

I repeat, one great mistake that the schools are still making, is the wrong mental habits that they are not merely allowing pupils to form, but compelling them to form. Slogans, solving words, petrified thinking are being substituted for experiments, analysis and the play of unfettered intelligence.

EXPERIMENTING

Charles A. Browning

Problem recognition. Have you curiosity about the things you see but do not understand? If so, you are likely to be conscious of many problems in your surroundings, which, for you, are yet unsolved. When you see occurrences in nature and in your everyday life, do you enquire of yourself, Why does this occur? What makes it act that way? If you do, you have been born with the natural curiosity of a scientist. Do you, when you have asked yourself these questions, have a natural inclination to seek the answer to your questions? For example: Did you ever notice that the strings of a violin or other stringed instrument do not all sound alike; that is do not have the same pitch? Provided you have noticed this fact, wondered why it was true and sought an explanation, you have recognized what, in science, we call a problem. In general we may say that the problem seeking attitude is the first characteristic of a scientist.

In order to recognize a problem you must be (1) observant, (2) curious, (3) a reader and (4) have a natural inclination to want to know the Why? about things. By observant we mean seeing with your mind; not merely with your eyes. Think about the things you see. By curious, we mean wondering about the things you see but do not understand. By being a reader we imply that if you read about the facts and things in your environment *you will become conscious* of many things which you have previously seen only with your eyes. Some people are, by nature, investigators; others, simply do not care to take the trouble to investigate. The latter never see any problems to be solved, while the former sometimes become our greatest scientists.

Defining the problem. When you have become conscious that a problem does exist in a certain situation and you have a keen desire to find its solution, the scientific method dictates that you experiment with the elements of the situation. By experimenting we mean putting a question to Mother Nature and interpreting her answer. But Mother Nature has a language all her own, so we will have to tell you just how to ask your question and help you to understand her answer. She can answer but one question at a time. You will, therefore, always have to make sure that your problem is not several problems in one. If so, you will have to divide it up and attempt to solve each part separately. For example: the violin strings referred to in an earlier paragraph do not all have the same pitch. But if you will pluck the strings, changing the tension on the strings as you do so, you will find that this changes the pitch. Now change the length of one string by changing the point at which you finger the string. You will find that this also changes the pitch. It is, therefore, clearly evident that in this problem of finding the cause of change of pitch, there are two or more causes. Hence, it will be necessary to single out one of the parts of your problem and attempt its solution. In scientific language, this process of picking out the integral parts of a problem is known as *defining and limiting the problem.* It is a very important step in experimentation. Your problem has now become: What are the causes of change in pitch and *how* does *each* cause *affect* pitch? In any experimentation this step of breaking up and defining the problem must be carefully carried out.

Setting up the experimental equipment. In order to perform most all experiments it is necessary to create an appropriate experimental situation. This is usually done with some kind of appropriate equipment. Your experimental situation must be, in all respects, similar to the life situation in which you found your problem. So with the equipment; *i.e.,* if you are going to set up experimental equipment to solve the problem outlined in the preceding paragraph you would not need, necessarily, to have violin strings, nor even a violin; but you might better use two strings of any similar material so arranged on a board that the lengths and tensions of the strings could be measured.

Measurements of some nature are essential to most experiments. Therefore, in experimenting in general, if there is any previous indication that the solution to the problem involves measurements it will be advisable to devise the experimental equipment so that measurements can be easily made.

Some experiments are purely qualitative and do not require measurements. For example, if you simply wanted to know whether length affects the pitch of a string, it would not be necessary to make an accurate measurement of the string.

Apparatus, as suggested in the foregoing paragraph, should be similar in all respects to a violin string on a violin; *i.e.,* its length, tension and size should be variable.

Manipulation of equipment. Having set up the equipment which is similar to the physical aspects of the life situation in which you found your problem, it is then necessary to bring about conditions, through manipulation of the apparatus, which are like the conditions observed in the particular life situation. An example of this would be to pluck the strings on the apparatus changing the length or tension as you do so. You have previously observed that both length and tension affect pitch. Hence, in this problem, it would be necessary to keep tension constant and vary the length of the string, observing pitch variations as you do so. So with *any* manipulation. Eliminate all variables except one pair and proceed to find the effect of one variable upon the other. If this is done and one variable is always found to affect the other, then the one may

be said to be the cause and the other the effect.

Observation. The next step is to find *how* one effects the other. To do this it is necessary to measure, in some suitable way, one variable and also measure the other variable under the same conditions. One set of measurements is not enough. Many sets of corresponding measurements must be made and the data tabulated. For example, observe the pitch of the note emitted by a string 100 cm long. Call this note do. Now observe the pitch of a second similar string under the same tension as the first but only 50 cm long. Is this note not do′? If so record the two pair of measurements in a table like the one below, calling the pitch of the 100 cm string 1, and the pitch of the 50 cm string 2. You do this because you will recall from your study of music that when notes are related as do and do′ that one has twice the frequency of the other. If you do not think that the note emitted by the second string is do′, then record the note you think you *do* hear. In this as in *any experiment,* many trials under the same conditions are necessary in order to gain sufficient data upon which to base a conclusion.

Table I

	Length	*Pitch (ratio)*	*Length*	*Pitch*
Trial 1	100	1	100	2
	50	2	66 2/3	3/2
" 2	100	1	100	1
	50	2	66 2/3	3/2
" 3	100	1	100	1
	50	2	66 2/3	3/2

It is necessary to vary the conditions; *i.e., change* the value of one of the variables. In the case in hand, you would next make the second string 66 2/3 cm long. You might make it any length, but we use this length because it makes a convenient example. You would thus continue your measurements until you had a considerable body of data. It is customary to assign to the work which has just been described the term, *observation.* This is one of the steps of experimentation; but observation goes farther than simply making measurements.

In addition to making measurements, you must be (1) very accurate. By this we mean: care in making measurements, critical of your apparatus, critical of your method and critical of your measuring device. (2) Have a clear cut idea of what you expect to see. (3) Be not so interested in what you expect to see that you fail to see the *unexpected;* but be sure to find the causes for the exceptions. (4) Do not begin an experiment with a "Now, what am I supposed to get?" attitude; be open minded. (5) Observe often and extensively under varying conditions. (6) Give particular attention to similarities and dissimilarities in your data. To illustrate the last point: In the table of data which you obtained from varying the length of a string and noting the corresponding variation in pitch, do you see any constant mathematical relation between the length of the two strings and the ratios of the notes emitted by them? Yes, you notice that in all the cases (provided you worked accurately) that the ratio of the length of the strings is equal to the inverse ratio of their frequencies, or pitch. In experimenting, not all data present such an apparent relationship, but you should search carefully until you find such definite relationship, or relationships in your data, or else, make sure that *no* definite relationships exist between the different factors represented by your data. Had there been a single case in your data which was at wide variance with the remaining data you should have been very careful to find its explanation.

Analysis and synthesis. While discussing the "definition of the problem" it was pointed out that the problem—any problem—must be limited. While observing life

situations in which problems are ever occurring, we are often conscious that a problem, even when limited, still has one or more problems contained within the limits already set up. In cases where there are several problems in one, the essential elements must be picked out. For example, in the case of vibration strings we recognized the fact that strings may vary in pitch with both length and tension. Now let us see what other factors *might* vary the pitch. Perhaps the size, or the material of the string, or even the way the string is made might have some effect upon pitch. So with any problem; it must be subjected to analysis.

You will now need to set up apparatus and solve each integral part of your problem, if possible, along the same lines as have been suggested.

Selective recall. Proceeding on the assumption that, you have subjected the problem—What determines the pitch of a string?—to analysis and that through careful observation have obtained certain data, you are now ready to take the next step in experimentation, namely, selective recall. By selective recall we mean: Have you had any experiences which conflict or concur with your experimental findings? Have your experiences gained through reading always been in accord with those gained through experimenting. If not, you should always attempt to find explanations for the discrepancies. A frequent explanation is, that the conditions in experiment and life situation were not comparable.

Hypothesis. Let us now assume that you have set up apparatus and obtained data upon the pitch of vibrating strings under all possible variable conditions. Let us assume still farther that you have reflected for some time upon your results and associated your results with your past experiences in connection with vibrating strings.

You are now ready to state a ***hypothesis*** or supposition as to the probable relation of pitch to the several variable factors in the experimental situation which you have set up. Perhaps you are ready to make the following tentative statements: (1) Pitch varies inversely as the length of a string; (2) Pitch is not affected by loudness; (3) Pitch varies directly as the square root of the tension on the string; (4) Pitch varies with the mass per unit length of the string.

This is the scientific procedure or the appropriate next step to take at the corresponding point in *any* experiment which you may have done. NOW READ CAREFULLY. This is the point in the experiment at which many students are ready to stop. They are prone to think that all has been done that can be done. But not so. Inferences must be tested. The true scientist never stops until he has performed many experiments.

Reasoning. The *real* scientist tries to disprove his own hypothesis. He asks himself if his data are adequate; if there were any exceptions which remain yet unexplained. *These things,* you also should do.

Now arrange all your data in order in a table. Do your data all point the same way? Are any measurements at great variance? Did the additional data change the general trend of your results? Are some of your data inconsistent with the other data? If so, rearrange your data or you may even need to discard some of it as irrelevant.

Conclusions. You are now ready to state your conclusion, which is the most concise statement which you can formulate of the facts which you think you have ascertained.

The foregoing discussion gives you, in considerable detail, illustrated by a single experiment, the steps in the experimental method of solving problems. It will be worth your while to study this discussion with care and then follow out the suggestions here outlined when you attempt the solution of problems by experimentation.

Abstracts

GENERAL EDUCATION

HURD, A. W. "How May Present-Day Educational Practices be Improved?" *School and Society* 39:442–444; April 7, 1934.

This is the résumé of an investigation made to determine to what extent there is agreement among groups with different academic interests on questions of educational philosophy, the purposes of education, methods of procedure, and so on. A list of 102 significant statements obtained from the publications of 56 authorities in the field of education was submitted to 154 persons. The agreement among the various groups was significantly identical. —C.M.P.

MCCALL, WILLIAM A. "My Philosophy of Life and Education." *Teachers College Record* 35: 560–572; April, 1934.

The author advances and discusses the following theses: (1) goals of education should be assembled in terms of human purposes; (2) the goals should be democratically discovered through a survey of the purposes of both representative adults and children; (3) there exist reasonably adequate techniques for surveying purposes; and (4) a curriculum built around purposes would be infinitely dynamic. —C.M.P.

BRIGGS, THOMAS H. "If There Were Millions." *Teachers College Record* 35:633–666; May, 1934.

A list of twenty-one means of promoting secondary education are proposed and discussed. The list follows: (1) defining the good life; (2) planning comprehensively for secondary education; (3) determining the special functions of secondary education; (4) learning the foreign schools; (5) knowing the school population; (6) defining education; (7) determining types of organization; (8) listing desirable activities; (9) directing and coordinating research (10) preparing teaching units; (11) developing teaching units under ideal conditions; (12) developing teaching units under normal conditions; (13) preparing curricula; (14) measuring results; (15) popularizing the program; (16) training teachers of unusual promise; (17) involving teacher-training institutions; (18) devising a record system; (19) planning for guidance; (20) providing for articulation; and (21) planning for buildings and equipment. —C.M.P.

DOUGLASS, HARL R. "Abstracts of Unpublished Masters' Theses in the Field of Secondary-School Administration." *Bulletin of the Department of Secondary-School Principals of the National Education Association,* No. 47, May, 1933.

The title of this bulletin is indicative of its content. All theses in this number were written at the University of Minnesota. The form for the abstracts includes the following: problem; data and technique of investigation; findings and conclusions; and summary. The bulletin will be of service to research workers in the field of secondary-school administration who wish exhaustive surveys of work done in the field. No studies are included which bear directly upon problems of science instruction. —R.K.W.

"Economies in Secondary-School Administration." *Bulletin of the Department of Secondary-School Principals of the National Education Association,* No. 48, December, 1933.

This bulletin consists of a compilation of suggestions for economy in administration contributed by various members of the organization. Economies are classified under the following headings: activities; school annual; athletics; bus; class procedure; clerical work; diplomas; federal aid; fees; operation; post graduates; pupil assistance; pupil exclusion; summer school; supervision; teacher load; and tuition.

Teachers of science along with other classroom teachers will be especially interested in the proposals under class procedure and teacher load. A suggestion under class procedure is the reduction of the time schedule of all science classes to single fifty minute periods. Under teacher load, the general story is the increase in class size and consequent reduction in the number of teachers required to handle a given number of pupils. No data upon the wisdom of these moves as they affect the quality of instruction are given.

—R.K.W.

SCIENCE EDUCATION—GENERAL

Noll, Victor H. "Measuring Scientific Thinking." *Teachers College Record* 35:685–693; May, 1934.

This is the third in a series of articles on scientific thinking that has appeared during the year. "The Habit of Scientific Thinking" and "Teaching the Habit of Scientific Thinking" appeared in the October and December, 1933, issues of the *Record*. In this article, the author describes the construction of a series of tests. —C.M.P.

"Twenty-third Annual Report of the Brooklyn Botanic Garden." *Brooklyn Botanic Garden Record* 23:13–170; April, 1934.

Director C. Stuart Gager presents the report for the year 1933, giving attention to the effect of the depression upon the activities at the Garden, the public relations and attendance, research activities, cooperation with other institutions, the place of the Garden in public education, the services to local schools, and other phases of the excellent work being done by the institution. Following the director's report are found the reports of the different curators. Teachers of general science and biology will discover in this report many valuable suggestions. —C.J.P.

Anonymous. "Your Money's Worth." *Turtox News* 12:137–138, 152–153; March, April, 1934.

Although of the nature of advertising the products of the company that publishes *Turtox News*, this series of articles, dealing with the requisitioning and purchasing of biological specimens, contains valuable suggestions for the teacher of biology. —C.J.P.

Murlin, John R. "Science and Culture." *Science* 80:81–86; July 27, 1934.

An old subject is discussed in a new way in this dedicatory address delivered at the opening of the new science building at Ursinus College. The article elaborates, by reference to the work and significance of great scientists, three ways in which science may strengthen the human spirit. These three sources of strength are: (a) confidence that the solution of life's problems lies in the use of reason and not of passion or propaganda, (b) simple, unaffected pleasure in finding things out for oneself, and (c) love of truth—not as something of one's own to be defended or advocated, but as something universal, belonging to all. Science teachers will find in the article much meat for thought and sustaining help for their professional choice. —C.J.P.

SCIENCE IN THE ELEMENTARY SCHOOL

Palmer, E. Laurence. "New Life." *Cornell Rural School Leaflet* 27:3–32; March, 1934.

This excellent leaflet will be found very useful by elementary-science, general-science and biology teachers. Seldom does one find in print, suitable for the beginning student, a better presentation of the topic of reproduction. Illustrated. —C.M.P.

Zachari, Elizabeth D. "Field Trip Experiences in the Intermediate Grades." *The Journal of Geography* 33:49–60; February, 1934.

The article presents some of the values to be attained through the use of geography field trips, how the trips may be organized, and finally a description of some of the trips conducted by the author. —C.M.P.

Smith, Jeannette. "A Nature Study Activity." *The Instructor* 43:27, 71–72; June, 1934.

An illustrated unit on the construction and utilization of a vivarium in a primary room. —C.M.P.

Moore, Joselyn. "Collecting Insects." *Hobbies* (Buffalo Museum of Science) 14:95–100; June, 1934.

Here are some valuable suggestions on the collecting and preserving of certain butterflies and moths by one of the science guides at the Buffalo Museum of Science. —C.J.P.

West, Joe Young. "Building A Nature Trail." *The Instructor* 43:31; 69; June, 1934.

This is an outline of a unit of work on the utilization of native materials commonly found in the environment. A detailed discussion of the activity involved in developing the unit is given. —C.M.P.

Wolff, Priscilla. "A Science Project." *The Instructor* 43:42; 67; June, 1934.

A description of a science project relating to the evaporation of milk. Illustrated. —C.M.P.

SCIENCE IN HIGH SCHOOL

Sigerfoos, Charles P. "Sections of Ameba." *Turtox News* 12:129; February, 1934.

On the basis of several years of experience in the use of sections of *Ameba dubia* in zoology classes at the University of Minnesota, the author offers directions and suggestions concerning the cultivation of these protozoa and the preparation of microscopic slides. —C.J.P.

Culp, V. S., Noyes, W. A. and Reed, Rufus D. "Report of the Committee on Chemistry Libraries." *Journal of Chemical Education* 11:114–123; February, 1934.

A comprehensive, annotated bibliography of books and magazines primarily for high school libraries. It includes publications under the following headings: "Popular Books on Chemistry"; "High-School Texts"; "High-School Manuals and Workbooks"; "Tests"; "Chemical Calculations"; "Teaching of Chemistry"; "History of Chemistry"; "Dictionaries and Handbooks"; "Physical and Theoretical"; "Miscellaneous"; "Analytical"; "Inorganic and General"; "General, Inorganic, and Miscellaneous College Chemistry Manuals"; "Organic"; "Foods and Biochemistry"; "Industrial"; "Magazines Recommended for High-School Chemistry Libraries." —V.H.N.

Wakeham, G. "From Concrete to Abstract in Elementary Chemistry." *Journal of Chemical Education* 11:168–169; March, 1934.

A suggestion that first courses in chemistry begin with concrete, physical matters which the pupil can easily perceive and understand. It is suggested, furthermore, that the major portion of the work in such courses deal with factual matters, practical applications, and industrial processes, and that chemical theory be deferred almost entirely to later courses. This would make the course more interesting and helpful to the pupil, and pedagogically more sound. —V.H.N.

Browne, C. A. "Observations upon the Essential Oil Industries of Foreign Lands." *Journal of Chemical Education* 11:131–141; March, 1934.

An illustrated article describing the production, and processes of manufacture of perfume oils, turpentine and rosin in the Riviera of France. —V.H.N.

Warren, L. E. "Chemistry and Chemical Arts in Ancient Egypt." Part I. *Journal of Chemical Education* 11:146–153; March, 1934.

The Egyptians were probably the most intelligent and the most learned people of ancient times. Their methods of manufacturing pottery and glass, the smelting and refining of common metals, and the manufacture of alloys are described and illustrated. —V.H.N.

Brown, H. Emmett. "Science in the New Secondary School." *Teachers College Record* 35: 694–707; May, 1934.

After describing the critical state of secondary-school physical science and discussing probable causes for this, the author advances some pertinent arguments for the teaching of science as a separate body of knowledge. The author sets up certain desirable and valid criteria for determining the content of a physical-science course that shall be required of all students. The course, as outlined, would be organized around broad science themes. —C.M.P.

SCIENCE

Smith, Ralph W. "What is a Fifty-Pound Weight." *Scientific Monthly* 38:111–117; February, 1934.

The author, who is chief of the section of weights and measures of the National Bureau of Standards, presents first a brief history of weight measurements and then proceeds to define scientifically what is meant by a "pound" weight. —C.M.P.

Abel, John J. "On Poisons and Disease and Some Experiments with the Toxin of the Bacillus Tetani." *Science* 79:63–70; January 26, 1934.

This is the address made at the Boston meeting by the retiring president of the American Association for the Advancement of Science. It is an excellent popular treatise on poisons and disease. —C.M.P.

Anonymous. "Robert Wilhelm von Bunsen: Teacher, Scientist and Inventor." *The Laboratory* 6:19–21.

A brief résumé of the life and work of this famous chemist is given. Reference is made to his discovery of ferric hydroxide as an antidote to arsenic poisoning, his only publication which related to furnace gases, and his invention of the Bunsen electric cell, the grease-spot photometer, the Bunsen burner, a glass filter pump, the ice-calorimeter, and the spectroscope (with Kirchoff). —C.J.P.

Tesla, Nikola. "Possibilities of Electro-Static Generators." *Scientific American* 150:132–134, 163–166; March, 1934.

An illustrated article in which this inventive genius makes brief reference to the history of electro-static generators and states that, in his opinion, the importance and practical value of the Van de Graaff generator has been over-estimated. —C.M.P.

Conklin, Edwin C. "A Generation's Progress in the Study of Evolution." *Science* 80:147–156; August 17, 1934.

This Penrose Memorial Lecture, delivered before the American Philosophical Society in April, 1934, is concerned with recent work on the methods and causes of organic evolution. After reviewing briefly the conclusions regarding the factors of evolution presented by leading evolutionists in a symposium before the same society in 1896, the author traces in a lucid way the contributions of Bateson, DeVries, Johannsen, McClung, Wilson, Montgomery, Sutton, Morgan,

Muller, Goldschmidt and other workers in the field. The lecture provides for teachers of biology an excellent overview of the milestone thoughts and experiments in this aspect of biology. —C.J.P.

Gleason, Sterling. "Slanted Oil Wells Work New Marvels." *Popular Science Monthly.* 124:40–41; 117; May, 1934.

A discussion of new methods that may revolutionize oil-well drilling and open up the way to the development of fields under mountains and beneath the ocean floor. —C.M.P.

Cooke, George. "Deadly Snake Poison Saves Human Lives." *Popular Science Monthly* 124: 29–30, 118; May, 1934.

This illustrated article shows how venom is extracted from poisonous snakes and discusses the experimental use of venom in the treatment of cancer and other diseases. —C.M.P.

Davis, William Morris. "The Faith of Reverent Science." *The Scientific Monthly* 38:395–421; May, 1934.

This is the second Maiben lecture presented at Boston meeting of the A. A. A. S. by the late William Morris Davis, eminent geographer and geologist. The address directs attention to the enormous service of science in liberating the human mind from century-long subjection to ancient dogmas, a liberation which enables man to enjoy freely the modern understanding of the world and man's place in it. The second part of the lecture considers the responsibilities placed upon man by this liberation. —C.M.P.

Hull, Thomas G. "A Century of Progress in Medicine." *Hygeia* 11:1109–1112, 1144–1146; December, 1933.

In this article, Dr. Hull discusses the field covered in the exhibit entitled, "A Century of Progress in Medicine," arranged by the American Medical Association for the Century of Progress Exposition. He outlines the outstanding discoveries in medicine made during the last century with a brief comment regarding their influence on progress in medicine. He contrasts the differences in techniques and equipment of early doctors with those of the present day physician and traces the development of medical training accompanying the progress in medical knowledge. The work of the American Medical Association in the improvement of standards in medical education is emphasized. A chronological table indicating the extensive activities of this Association gives the reader an idea of the scope of its influence. —F.G.B.

Symposium, "The Contributions of Science to Increased Employment." *The Scientific Monthly* 38:297–309; April, 1934.

In this symposium a group of eminent scientists refute the oft-made charges that science is the cause of much unemployment. The authors and the title of their addresses follow: Karl T. Compton "Science Makes Jobs"; Frank B. Jewett "Science and Industry"; Robert A. Millikan "The Service of Science"; and W. D. Coolidge "Scientific Developments and Their Applications." —C.M.P.

Hildebrand, Joel H. "The Liquid State." *Science* 80:125–133; August 10, 1934.

In this address of the retiring president of the Pacific Division of the A. A. A. S., the speaker presents experimental evidence and theoretical consideration to show (a) that the liquid state represents a certain range in the kinetic energy of the molecules; (b) that there exist between molecules polar and non-polar forces which depend upon the nature of the constituent atoms and upon their geometrical arrangement, (c) that there are wide variations in the strength of the polar and non-polar forces, and (d) that the liquid state may be better understood by the study of mixtures of molecules of the same and of different types. The instructor in physics will find in the article suggestions for some excellent demonstrations and a background of fact and theory which will make his teaching of "change of state" more inspiring to students. —C.J.P.

Chapman, Frank M. "A Season's Bird Guests." *Natural History* 34:16–30; January, February, 1934.

An illustrated article about the furred and feathered inhabitants of Florida. —C.M.P.

Ward, Henry B. (Editor). "The Berkeley Meeting of the American Association for the Advancement of Science." *Science* 80:43–62; July 20, 1934.

The permanent secretary of the A. A. A. S. reports the high spots of the ninety-fourth meeting of the association held at Berkeley in June, 1934. The report contains a brief résumé of the proceedings of each of fifteen sections of the association. It provides an excellent overview of the major current problems and researches in the different fields of science. —C.J.P.

Crane, E. J. "Nomenclature of the Hydrogen Isotopes and Their Compounds." *Science* 80: 86–89; July 27, 1934.

The recent chemical literature has carried so many references to protium and deuterium and their compounds, particularly "heavy water," that teachers of chemistry will be happy to peruse this preliminary report of the Nomenclature, Spelling and Pronunciation Committee of he American Chemical Society aided by representatives of the American Physical Society. A formal report with definite recommendations is promised. —C.J.P.

Andrews, Roy Chapman. "Nomads of the Desert." *Natural History* 34:31–44; January, February, 1934.

A description of the people of Mongolia and their environment is presented with illustrations. —C.M.P.

Grey, Zane. "The Great Mako." *Natural History* 34:221–234; May, June, 1934.

The author offers a description of the great Mako, a famous leaping fish found in New Zealand waters. It attains a weight of 500 to 1000 pounds and has been known to leap as high as thirty feet. Illustrated. —C.M.P.

Rutherford of Nelson, Lord. "The New Hydrogen." *Science* 80:21–25; July 13, 1934.

This famous physicist reviews the revolutionary changes of the last two years in our ideas of the constitution of water. How heavy hydrogen was discovered, how heavy water was first prepared, the importance of hydrogen isotopes in chemical compounds, and the relation of heavy water to plant and animal growth are discussed. There follow suggestions on the nomenclature of the isotopes and a final section on the use of heavy hydrogen in the bombardment and disintegration of light elements. —C.J.P.

Ford, William W. "Development of Our Early Knowledge Concerning Magnification." *Science* 79:578–581; June 29, 1934.

The author tells the history of the simple lens, curved mirrors, the simple microscope, the compound microscope, the magnifying telescope, the achromatic telescope and microscope, the water-immersion lens, and the oil-immersion instrument. This is excellent material for the teacher of physics and for supplementary reading by students of biology and physics. —C.J.P.

Humphreys, W. J. "The 'Sinking' of Lake and River Ice." *Science* 79:562–563; June 22, 1934.

An expert meteorologist answers the obsession of the boatman, fisherman, and others who believe that surface ice becomes honey-combed and sinks in the spring of the year. Seven matters of scientific pertinency are stated to explain that the ice just melts in a hurry and does not sink at all. —C.J.P.

Clark, N. A., and Thomas, B. H. "Microorganisms and Vitamin Production in Green Plants." *Science* 79:571–572; June 22, 1934.

This brief article attempts to refute, on the basis of experimental evidence, the idea that the action of microörganisms is the effective factor in producing vitamins in green plants. It also points to the conclusion that variation in light within limits has little effect upon vitamin production. —C.J.P.

Bailey, Alfred M. "Wanderers of the Seas." *Natural History* 34:273–281; May, June, 1934.

The article describes the albatrosses that nest on coral and volcanic rocks in the mid-Pacific. Illustrated. —C.M.P.

Gross, F. P. Jr. "Rare Gases Become Common Chemicals." *Report of the New England Association of Chemistry Teachers* 35:74–84; April, 1934.

The author presents in this article especially valuable information for the instructor of general science and chemistry. Following a brief historical account of the discovery of the rare gases, attention is directed to the sources of the gases, their physical properties, their position in the periodic table, and the commercial applications of the elements. It is illuminating to learn that it would take a man 2100 years, breathing normally, to inhale a volume of neon equal to the volume of one breath of air, that it would take 2,000 years to obtain enough helium from the air, by the usual method, to inflate a Zeppelin, that neon has electrical conductivity 75 times as great as air, and that one cubic foot of neon will fill about four miles of average sign tubing. —C.J.P.

Carr, William H. "Trailside Unnatural History." *Natural History* 34:287–296; May, June, 1934.

A résumé of "strange and amazing tales" that visitors have related when visiting the Bear Mountain Trailside Museum. Illustrated. —C.M.P.

Anonymous. "No Living Honeybee Has Ever Stung a Human Being." *Science News Letter* 35:350; June 2, 1934.

James I. Hambleton of the United States Department of Agriculture is quoted as saying that all honeybees die soon after stinging a person, that there are no domesticated honeybees, and that they do not know their keepers. —C.M.P.

Anonymous. "The Noise Laboratory." *The Laboratory* 5:61–62.

This brief article sheds some light on the noise meter, or acoustimeter, for measuring the loudness of noise, devised by E. E. Free. Interesting comparisons of the loudness of different noises are given. The "decibel" is defined. —C.J.P.

Henderson, Yandell and others. "The Third Major Mechanical Factor in the Circulation of the Blood." *Science* 79: 508–510; June 1, 1934.

Teachers of biology and general science who teach the circulation of the blood will discover in this article a point of view not incorporated in the usual explanation of how circulation takes place. The authors disagree with the idea that poor circulation lowers the general body tonus and propose to reverse the present conception of cause and effect, reaching the conclusion that the tonus of the muscles is the principal force involved in venous return of the blood to the heart. —C.J.P.

Thatcher, R. W. "A Proposed Classification of the Chemical Elements with Respect to Their Functions in Plant Nutrition." *Science* 79: 463–466; May 25, 1934.

This article is an attempt "to correlate the known or possible functions of the different elements in plant nutrition with their chemical properties as functions of their atomic numbers and position in their systematic arrangement in the periodic table." It is pointed out that all of these elements are included in the first four orbits of the periodic table and that they may be grouped according to their specific functions. —C.J.P.

Oak, Mrs. David E. "Quotations for Arbor Day." *Nature Garden Guide* 12; April, 1934.

This issue presents appropriate excerpts from literature to be used with elementary-school children on arbor day, a suggested arbor day program, and a brief list of books on trees.

—C.J.P.

Anonymous. "Chinese Alchemy." *The Laboratory* 6: 34–37.

Those interested in the beginnings of modern chemistry will delight in the factual, historical information contained in this short article. The Chinese, like other early peoples, were eager to determine a means of prolonging the life of man. They, therefore, as philosophers and alchemists, sought to prepare the "Pill of Immortality." The quoted translations of the writings of Wei Po-yang on alchemy are fascinating. —C.J.P.

Anonymous. "Preview into Future of Science." *Science News Letter* 35: 356–358, 366–367; June 9, 1934.

Statements of 41 leaders in industry and research estimate what the next century may bring in pure and applied science. —C.M.P.

Anonymous. "The Evolution of Weights." *The Laboratory* 5: 54–57.

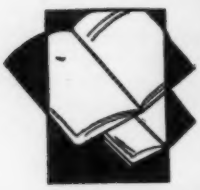
Beginning with the old stone weight of Dudu, unearthed during recent years and now on exhibition in the Ashmolean Museum at Oxford, the article continues with a description of weights after Dudu, standards of weight in the United States, the weights of the International Bureau of Weights, and standards of weight in Canada. The kind of information given in the article will add interest and life to the usual dead-weight material in textbooks of general science and physics. —C.J.P

Graves, Arthur H. "Report on Winter Injury of the Woody Plants in the Brooklyn Botanic Garden, 1933–1934." *Brooklyn Botanic Garden Record* 23: 171–209; July, 1934.

Teachers of biology will read in this excellent report interesting data on the effect of extreme cold periods on a large variety of gymnosperms and angiosperms. "Extreme cold periods like that of the winter of 1933–1934 determine what kinds of exotics can be grown successfully in our region." The conditions during the past winter are described and the nature and explanation of the injuries are presented. A complete check list of the plants, showing conditions which they experienced and effects of the cold, is given.

—C.J.P.

New publications



HUNTER, GEORGE W. *Science Teaching.* New York: American Book Company, 1934. 552 p. $2.50.

There has been for some time a need for a comprehensive up-to-date classroom book on the teaching of science below the college level. A book was needed which would bring together the results of classroom experience of successful teachers of science and the results of experimental studies of science teaching which have accumulated rapidly in the last decade. In many respects this book fills the need. There are sixteen chapters covering the following topics: the history of science teaching in the United States, its objectives; the place of science in the curriculum; methods; the scientific method; the textbook in science; motivation in science teaching; visual aids; supervised study; individual differences; health education; science tests; the planning and organization of the science library, laboratory, and classroom; and the training of science teachers.

Throughout the book evidence from educational psychology, studies of educational methods, educational research in general and research in science teaching in particular is presented with emphasis on the relation of such evidence to classroom teaching. The book is replete with suggestions to the teacher on methods of teaching, with lists of references, textbooks, tests, courses of study, and with lists of sources of supplementary materials, visual aids, and the like. Each chapter is introduced by a short introductory statement or "preview" and is followed by a list of study questions and a bibliography.

This volume is essentially an attempt to introduce science teachers to a scientific viewpoint in the study of their own teaching, to make them aware of the nature and multiplicity of these problems, and to acquaint them with some of the evidence, experimental and otherwise, that is available. There is little in it with which the majority of experienced teachers of science will disagree. In most cases where evidence on problems of science teaching is presented it is accompanied by sound and pertinent criticism.

On the negative side a number of criticisms, for the most part of minor importance, and in some cases undoubtedly due to careless editing, may be mentioned. Among those of the latter type are (a) poor constructions and rather involved sentences in some portions (b) lack of uniformity in citations, and incomplete citations. These matters can all be corrected when the book is revised. Of greater importance are the following points: (1) The author fails to take into consideration a large body of experimental evidence in science teaching in the form of masters and doctors theses that is now available. Some of this is abstracted in Curtis' *Digests* and much additional material of this type can be had for the asking from bureaus of educational research in institutions where graduate study is carried on. A book which aims to cover the experimental evidence on science teaching may not ignore this material, some of which is most significant. (2) The author implies that Gestalt psychology has large implications for modern science teaching but he places major emphasis throughout the book on the teachings of Herbart and Spencer. It is not always clear what psychological viewpoints the author holds. There are undoubtedly phases of the teachings of both Herbart and Spencer which are applicable today, but they could scarcely be called Gestalt. (3) The chapter on health education could be improved by showing more definitely just what part instruction in each of the various sciences should play in health education. In other words, the chapter presents the need for health education but fails to show clearly what science teaching should do about it. (4) The chapter on testing could be made more serviceable by giving more information as to reliability, validity, norms, nature of the questions, *etcetera*, of the various available tests in science. Some of the best tests now available are not mentioned at all.

Probably none of these criticisms represents serious weaknesses in the book. In the opinion of this reviewer, it is the best that has appeared in this field, and should enjoy a wide usage for years to come. —V.H.N.

MCCORKLE, PAUL and LEWIS, J. ARTHUR. *College Physical Science.* Philadelphia: P. Blakiston's Son and Company, 1934. 327 p. $2.00.

This is another of the recent general physical science texts for junior college students. The authors have labelled the text as intended as an orientation course in physical science. It is an attempt to meet the needs of students with little previous science training who expect to go no further in science, those who may go into special

sciences as specialists, and those who intend to become teachers of science. This is a very large order for any one course or textbook.

The book is relatively brief. As compared with some of our recent high school compendiums it is only half as long as current high school general science and general biology texts. There is no attempt at unit organization. Each chapter deals with a particular phase of physical science, with little relationship to other material which may follow. The arrangement is compartmental after the fashion of earlier high school general science texts. The first part deals with elementary astronomy, the second with geology and physical geography, the third with chemistry, and the final group of chapters with physics.

The treatment is frankly descriptive. Little attempt is made to develop important principles or concepts of science. Teaching devices consist of a few laboratory or demonstration exercises; "problems" and topics for discussion; recommended visual aids; and brief reading lists.

The book will be of interest to junior college teachers of orientation courses in science. High school teachers interested in general physical scince courses in the senior high school will find this text within the range of high school seniors.

—R.K.W.

Downing, Elliot Rowland. *An Introduction to the Teaching of Science.* Chicago: The University of Chicago Press, 1934. 258 p. $2.00.

Out of his long study of the problems of the teaching of science and because of the many investigations in this field since the publication in 1925 of his *Teaching Science in the Schools*, the author has seen fit to prepare a new book dealing with the applications of these investigations to the profession of teaching science.

Beginning in Chapter I with an exposition of major goals and specific objectives of science in terms of changes effected in pupils through directed learning activities, the book proceeds to discuss in Chapter I the consumer science versus the producer science needed in our liberal, secondary curriculum. These two chapters constitute the author's basic philosophy of science teaching and represent, in the opinion of the reviewer, a highly sound and practical basis for the later elaboration of the major objectives (Chapters III to V) and for the presentation and integration of the results of investigations relating to the science curriculum, organization units, methods of teaching, supervised study and testing results (Chapters VI to X). The last chapter presents a survey of present conditions in science teaching as revealed by a selected number of studies.

The publication represents a very important addition to the writings on science education, particularly in its statements of the aims of science teaching and in its analyses of the knowledge, skills in scientific thinking, and emotionalized standards which latter are designated as the major goals of teaching science. The clear, functional philosophy set forth in the first five chapters is in sharp contrast to many other writings on the subject which emphasize knowledge in science as a primary goal and consider the real essence and purpose of science, namely, the method and attitude, as of secondary importance.

In the treatment of the science curriculum (Chapter VI) the author is too brief to do justice to this important aspect of science teaching. True, there are not many studies directly relating to the determination of a curriculum in science, yet there are some which, coupled with the experiences of successful teachers of science, offer a fuller statement of the tentative principles and procedures in formulating a science curriculum than that presented in Chapter VI. It seems unfortunate that, under existing conditions, practically no mention is made of the place of general science in the science program of studies. Nor does one find a discussion of junior-high-school science.

—C.J.P.

Curtis, F. D., Caldwell, O. W. and Sherman, N. H. *Biology for Today.* Boston: Ginn and Company, 1934. 733 p. $1.76.

In their preface the authors say "Especial emphasis is given to development of the fundamental generalizations of biology and to establishing scientific attitudes." Two pages are devoted to listing and explaining some of the scientific attitudes. Attention is called to these attitudes at thirty-one places in the book totalling eleven pages of exercises to develop them. The longest single passage of this type of material, about one and a third pages, reviews certain work of Pasteur, Koch and Lister as illustrative of some of these attitudes. Thus less than two per cent of the book is given to biology as method. Still this is more than other texts give and the material is here better organized. About 40 per cent of the book is given to the discussion of major generalizations while the remainder is largely descriptive or factual.

The subject matter of the book is not so different from that of the average modern text, though some novel topics are treated, but the organization is the distinctive feature. The energy concept is the unifying idea and it is well handled in most of the units. In the unit on taxonomy and in "The Struggle for Energy through Succeeding Generations," including chapters on reproduction, inheritance and the geological record, there seems to be little reference to the energy concept except in the titles.

There are a number of new features in the book. The non-scientific vocabulary is kept within the 7000 level of *The Teachers Word Book*, by Thorndike. Less familiar words and scientific terms are defined in the text when first used and again in the twenty-five page glossary. There are four pages "To the student" on "Suggestions for efficient study." If the teacher sees to it that these

are faithfully followed they will prove very valuable. Each unit has a preview, "Problems discussed in this unit." Each chapter opens with a statement of the questions it discusses. Directions are given in the body of the text for eighty-three experiments. There are numerous self tests for the pupils and many suggested additional exercises and activities. The paragraphs that constitute the minimal essentials, about one hundred pages all told, are marked with an asterisk. Some thirty pages are given to leisure time biology.

The style is simple. The illustrations, newly made for this book, are illuminating. The book should prove a very teachable text. —E.R.D.

Hunter, George W., and Kitch, L. W. *Mastery Tests in Biology.* New York: American Book Company, 1934. Set X, 133 p.; Set Y, 135 p. $0.40 each.

There are about a hundred tests in each set on twenty units together with quarterly examinations on the units. The tests are of various sorts: true-false, matching, completion, naming parts on diagrammatic drawings, etc. They will serve as aids in study or to test the knowledge gained. They are not mastery tests in the sense that they demand ability to apply the principles of biology. More than 90 per cent of the questions merely require the recall of facts or the recall of statements of the text. —E.R.D.

Pieper, Charles J., Beauchamp, W. L. and Frank, O. D. *Teacher's Guidebook for Everyday Problems in Biology.* Chicago: Scott, Foresman and Company, 1934. 316 p.

While this is intended to accompany the authors' text-book it will be of interest to any biology teacher for the units treated are not unlike those of other texts. In part one, the objectives of science teaching, of biology in particular and the techniques of teaching are profitable reading no matter what text is used. Part three has suggestions for ordering, collecting and caring for living materials and other supplies, also, lists of books and bulletins that are helpful to all.

The graphs of the subject matter of the twelve units are ingenious and unusually clear. The teacher who is using *Everyday Problems* will be grateful for the added details on the conduct of experiments, for the analyses of the various problems and for the suggested answers to the many questions of the text. —E.R.D.

Carpenter, Harry A. and Wood, George C. *Our Environment: Its Relation To Us.* Boston: Allyn and Bacon, 1933. 393 p. $1.20.

This book is a revision of the earlier edition of Volume I of a three-volume series, and is intended to be followed by the second and third volumes. It is also recommended as an introductory text in general science when not used coordinately with the other volumes. The subject matter is presented in six units as follows: Water; Rocks and Soil; Air; Fire; Trees; Health. Each unit is divided into two or three sub-divisions or topics. For example, the unit on water is divided into the three topics, Water and Its Ways, Water as a Worker, and Sand and Water. Each of these topics in turn is presented in the form of several problems such as, Where and What is Water? Is Water Necessary to Life? What is the Water Cycle? Each unit is introduced by a preliminary statement, or preview.

The emphasis throughout the book is on the solution of problems by the pupil. To this end many experiments are included to be performed and interpreted by the pupil with or without the help of the teacher. At the end of each topic are key words to be defined, key statements which are to serve as topics for oral or written exercises, and thought questions to be answered. In addition to these, there are "Field Research Problems," projects for the "Science Discovery Book," which is a separate manual that may be used in conjunction with the text, and "Special Problems" for additional work. The book is written in a pleasing intimate style which should appeal to children at the junior-high-school level. It is well illustrated.

The authors are making in this book a most commendable effort to utilize the facts of science for developing habits of scientific thinking, and ability to use the scientific method. In this respect, at least, the book is distinctive. It goes beyond most textbooks in science in this matter by actually providing situations through the use of the techniques described above, in which the pupil may be given practice in the use of the methods of science and in which he may acquire some of the habits that constitute scientific thinking. —V.H.N.

Jean, F. R., Harrah, E. C. and Herman, F. L. (Edited by Powers, S. R.) *Man and the Nature of His Physical Universe.* Boston: Ginn and Company, 1934. 524 p. $2.20.

This book is, according to the preface, avowedly an attempt to present consumer rather than producer science—to give the student such a familiarity with the principles of science as will enable him to meet his life needs in this field.

Unit I, of 140 pages, discusses the universe in which we live and some of the methods by which astronomers have arrived at the facts detailed. Unit II treats the nature of matter and energy, physical and chemical changes, magnetism, electricity and radiant energy. Unit III deals with machines and inventions, Unit IV with the hydrosphere, atmosphere and weather, Unit V with the forces that have changed the face of the earth and that have brought within man's reach valuable minerals.

About half of the book presents facts that have little or no bearing on the principles of science. Three-fourths of the remainder deals with questions the average man might want answered to satisfy his curiosity, one-fourth with problems

that man must do something about, that is, practical rather than curiósity problems. Many of these are discussed in terms of how things work rather than on the basis of principles that explain the "why" of their operation.

The preface criticizes the traditional courses in science on the grounds that they have been presented from the point of view of the subject matter specialist. Certainly such topics as Stetson's theory of the origin of glacial periods (page 56), the planetesimal hypothesis (110), Bohr's theory of the structure of the atom (159), the origin of cosmic rays (167), the quantum theory (271) the theory of isostasy (451) smack more of the speculations of the specialists than of the science needs of the man of the street.

All of which goes to show how difficult it is going to be to get away from traditional courses in science and meet the every-day needs of the average man. At least here is a book that goes a long way in the right direction. And it is exceedingly well done. Facts are strikingly stated and interest in the topics treated is well sustained. It should prove a very stimulating text for a college survey course in physical science. Other books will follow that will stick closer to consumer science but none better is now available. If the college student leaves it at home after his course it will likely be read with avidity by most of the family. —E.R.D.

Towse, Anna B., Gray, William S., and Matthews, Florence E. *Health Stories, Book Two.* Chicago: Scott, Foresman and Company, 1934. 176 p. $0.68.

Years ago little children were taught to read without much attention being given to what they read. The idea seemed to be that they would first learn to read, then find something upon which to practice this acquisition. We now know that little children learn best if they do so by working upon something which appeals to them as worth doing. *Health Stories* is an excellent illustration of recent discoveries about how and why children learn to read. The topics and pictures deal with worthwhile matters. The vocabulary is the result of definite studies. The composition and coherence provide engaging and cumulative experience. That is, from the pupil's point of view, he is learning interesting things about health. From the teacher's point of view, not only does health knowledge grow, but through that growth the best kind of advance is made in reading ability.

For upper first grade and for second grade, this book seems to be a distinct contribution.
—O.W.C.

Carpenter, H. A. and Wood, George C. *Science Discovery Book.* Boston: Allyn and Bacon, 1933. 159 p. $0.55.

In this work are combined a manual for reporting results of experiments in general science and a workbook. The last fifteen pages are made up of tests. The book represents more, however, than the ordinary manual or workbook in that a definite attempt is made throughout to teach the elements of the scientific method. Some of the characteristics of real scientific experimentation are constantly held up as goals to the pupil in his work, and provision is made for him to keep a continuing record of his attainments in using and acquiring such methods. An attempt is also made to help the pupil to distinguish between knowledge from hearsay, from reading, and from observation and experimentation. The success with which this publication is used must depend in large part on the teacher, her desire for and ability to make meaningful and worthwhile to pupils the goals which the book seeks to achieve. It impresses this reviewer as a distinct contribution to the teaching of scientific method in that it brings this objective out into the open and attempts to provide material for achieving it by direct instruction. —V.H.N.

Powers, S. R., Neuner, Elsie and Bruner, H. B. *The World Around Us.* Boston: Ginn and Company, 1934. 475 p. $1.20.

This is the first of a series of three science books constituting "A Survey of Science" for grades seven, eight and nine. The purpose of this one is to acquaint the pupil with the world around him; the second book takes up the changes going on in living and non-living things and the third the control of physical and biological phenomena.

The book treats several units: I. What is Science, 20 pages; II. The Relation of Living Things to Where They Live, 22 pages; III. Water Necessary to Living Things, 93 pages; IV. Air Necessary to Living Things, 123 pages; V. Soil an Important Factor, 37 pages; VI. Changes in the Composition of Things, 41 pages; VII. Heat, 37 pages; VIII. Relation of Living Things to Environment, 53 pages.

The volume undertakes to organize the experiences the pupil has had and to supplement them with numerous experiments so as to give an understanding of some of the common phenomena in terms of the principles of science. The preface states that the authors have endeavored to accomplish the objectives of science for the junior high school as set forth in the report of the National Society for the Study of Education, *A Program for Science Teaching, Thirty-first Yearbook, Part I,* 1932. These include not only an ability and desire to use the principles of science in solving everyday problems but also skill in scientific thinking and the acquisition of the scientific attitude. There are brief sketches of the life and work of nine great scientists, occasional citations of good examples of scientific thinking and problems that demand the exercise of such skill. Whether such meager materials will have any effect in promoting the desired skill only careful tests after the use of the book can determine.

There are some inaccurate and incomplete statements. The pupil will wonder (page 171) how he is to get the tube filled with mercury into the dish of mercury without spilling the contents

of the tube. On page 119, he will get the notion that alcohol lowers the freezing point of water for the same reason as does the salt in solution. But on the whole the book is simply and clearly written. The materials are well chosen. The illustrations are to the point. The style is informal and direct. The pupil is addressed as "you" and many of the experiences, both real and imagined, are related in terms of "we." Each unit has an interesting introduction. Each chapter is briefly summarized. There are numerous questions, suggestions for discussion and lists of things to do. It should prove an excellent textbook at the grade level for which it is intended.
—E.R.D.

Lake, Charles H., Harley, H. P. and Welton, Louis E. *Exploring the World of Science.* Newark, N. J.: Silver, Burdett and Company, 1934. 702 p. $1.76.

Here is another addition to our rapidly growing number of science texts for the junior high school. This book has many excellent qualities. The organization in teaching aids is especially to be commended. Most of the usual topics common to general science are found here. The inclusion of experiments along with the text is very helpful. The combined problem and unit division of subject matter is used. The unit ends with a self-testing exercise, thought exercises, and references for reading and study. —W.G.W.

Burdick, A. J. and Dudleston, M. S. *Physics Experiments and Problems.* Syracuse, New York: The L. W. Singer Company, 1932. 184 p. $0.69.

This is a laboratory manual and workbook combined, although the authors do not use the term workbook. It is divided into eight parts following the conventional order of most physics textbooks. Each part includes references to several textbooks, an outline for textbook study, an outline for laboratory experiments, suggestions for class demonstrations, standards of achievement, directions for the laboratory experiments, uncompleted statements or other exercises for each experiment, related questions and usually related problems. For each large division there are supplementary materials in the form of a scientific vocabulary, topics for class discussion, and a test. For all parts except the first, there is also a suggested list of projects for laboratory or home work. —A.W.H.

Burdick, A. J. and Dudleston, J. J. *Chemistry Experiments and Exercises.* Syracuse, New York: The L. W. Singer Company, 1933. 200 p. $0.69.

Laboratory manual and workbook are combined in this publication. All the usual experiments in the average manual are included here as well as a few extra ones. Each experiment is followed by a set of questions and problems in completion form. Many experiments are preceded by brief historical notes on the subject of the experiment. Drawings are reduced to a minimum in that most experiments supply the drawing of the apparatus set-up and the pupil is merely required to label the parts. In addition to the foregoing, there are lists of new words to be learned, topics for oral or written work, projects and review exercises. The work represents no radical departures either in form or content from accepted procedures but it does seem to combine in one publication most of those now generally accepted as preferred.
—V.H.N.

Ilin, M. *100,000 Whys.* Philadelphia: J. B. Lippincott Company, 1933. 138 p. $1.50.

A second part of the title of this book is, "A Trip Around the Room." The author introduces the book by saying that one does not have to make a trip to a foreign country in order to get adventure. A trip around the room with the attitude of discovery will reveal to him quite as much as a much longer trip to far-away countries might do.

There are six stations on the road traveled in the book. In order, they are "The Water Faucet," "The Stove," "The Cupboard and the Range," "The Kitchen Shelf," "The China Closet," and "The Wardrobe." The aim is to disclose some science about the common things one finds in his home by answering questions which one may ask about them. Some sample questions are: "Which is warmer, three shirts or one shirt three times as thick?" "Why do we blow on a match when we want to put it out?" "Is there such a thing as transparent iron?"

The explanations are written in simple language and interesting style suitable for children in the upper primary grades or older. Any layman can get information from the book which will be new and novel to him. —A.W.H.

Childs, W. H. J. *Physical Constants.* New York: E. P. Dutton and Company, 1934. 77 p. $1.20.

This is an English book giving definitions of physical terms and units of measure; numerical values of physical constants of all sorts; and tables of logarithms, antilogarithms, natural sines, cosines, tangents, reciprocals, and squares.
—A.W.H.

Baker, Arthur O. and Mills, Lewis H. *Activities for Dynamic Biology.* Chicago: Rand McNally and Company, 1933. 218 p. $0.80.

This is a workbook to accompany the author's *Dynamic Biology.* Each of the fourteen units begins with a preview and is followed by a series of problems relating to the unit. Each unit closes with a unit summary and self-checking exercises.
—C.M.P.

Fuller, Raymond T. *The Doorway to Nature.* New York: The John Day Company, 1931. 284 p. $2.50.

The author, an ardent student of nature, shares with his readers the joys and thrills of close asso-

ciation with living things in yards, woods, and fields. He seems to say to those unacquainted with the out-of-doors, "Come outside and I'll show you!" In a chatty, familiar style, he gives many suggestions to help the uninitiated become acquainted with living things, such as how to know many common plants and insects, how to "tame" wild flowers in the home garden, how to tell the age of a tree, how to go camping, and how to study the habits of common birds. In the chapter entitled, "It Just Isn't So," he discusses common fallacies such as toads give warts, bats fly into one's hair, dragonflies sew up one's ears, and the myth about the shadow of the groundhog and the coming of spring. A selected bibliography valuable in the identification of birds, mammals, insects, and plants is included. This book is truly a "Doorway to Nature."

—F.G.B.

Luckiesh, Mathew. *The Book of the Sky.* New York: E. P. Dutton and Company, Inc., 1933. 335 p. $3.00.

This is a new and revised edition of an earlier book that has been read widely by lay readers as well as by those interested in meteorology and aviation. The first edition was, in reality, a pioneer in the recognition of the day sky with which we all live but about which little is known by most people. The new volume includes many additional illustrations in the form of photographs taken by the author as well as seven new chapters entitled, "The Ways of the Winds," "Whence Weather?", "To Know Weather," "Lightning," "Bumpiness," "Measurements of Weather," and "The Sky Vault."

The book is an authoritative discussion of clouds, atmosphere, winds, and weather as they apply to air-travel. In the words of the author it is composed of "journeys in cloudland on the wings of experience and knowledge." The book is an outgrowth of experiences gained by the author while serving as an aviator during the World War and of his continued interest in aviation.

The charming adventurous manner in which the book is written will fascinate and stimulate the general reader to greater appreciation of the wonders of the day sky and will aid the aerial traveler to a more complete enjoyment and understanding of the sky and its ever changing moods.

—F.G.B.

Burgess, Thornton W. *The Burgess Big Book of Green Meadow Stories.* Boston: Little, Brown and Company, 1932. 202 p. $1.75.

This is written in the characteristic Burgess style, giving personalities to animal life, which is pleasing to young children. Incidentally, considerable natural information may be gained from reading the stories. There are numerous full-page color plates which are excellent and add greatly to the appeal the book makes to children. The type is large and the book can easily be read by third- and fourth-grade students.

—W.G.W.

Burgess, Thornton W. *Birds You Should Know.* Boston: Little, Brown and Company, 1933. 256 p. $1.25.

This little volume with a flexible cover easily slips into your pocket or handbag. There are illustrations of nearly four hundred birds common to the section east of the Mississippi River. The illustrations in natural colors are the work of the late Louis Agassiz Feurtes. The names and classifications are according to the 1931 check list of the American Ornithologists' Union. A brief test description in addition to the colored plates, makes identification relatively simple. It is a volume to take with you on your field trips and will be of much value in helping you to get acquainted with your bird neighbors.

—W.G.W.

Clement, Arthur C., Collister, Morton C. and Thurston, Ernest L. *Our Surroundings.* Syracuse, New York: The Iroquois Publishing Company, Inc., 1931. 628 p. $1.68.

This is an elementary science textbook for the junior high school grades. It includes forty-five chapters, thirteen of which bear upon physics and its applications; four on physical geography and astronomy; three on chemistry; twenty-one on biology; and the remainder on general topics of scientific interest. Among these are, "The Meaning of Science," "Science and Progress," and "Famous Scientists." Each chapter includes a summary, fact and thought questions, project suggestions, suggested outdoor observations, and references. The style seems interesting and suited to children of the grades cited. Photographs and other illustrative materials are plentiful. Other features of the book are six groups of "General Thought Questions for Discussion and Review," and an extended glossary.

—A.W.H.

Atwood, Wallace W. and Thomas, Helen Goss. *Home Life in Far-Away Lands.* Boston: Ginn and Company, 1933. 206 p. $0.96; *The Americas,* 1929. 316 p. $1.40; *Nations Beyond the Seas,* 1930. 352 p. $1.56.

These three books comprise a series of geographies on the single-cycle plan. *Home Life in Far-Away Lands* introduces pupils to geography through a series of imaginary journeys to the homes of children in distant lands. The excellent pictures and maps are so arranged as to form an integral part of the learning process. Especial attention has been paid to the vocabulary, so as to make the text free from reading difficulties. A list of books for outside reading is included.

The Americas and Nations Beyond the Seas are designed to follow *Home Life in Far-Away Lands.* The basic framework of these books is regional. Otherwise the texts have similar treatment and teaching devices as *Home Life in Far-Away Lands.*

Teachers will find these geographies up-to-date in content, method of approach, and in teaching devices. Few if any geography texts will rate superior in teachableness. —C.M.P.

McConnel, W. R. *The United States in the Modern World.* Chicago: Rand, McNally and Company, 1933. 305 p. $1.32.

The unit technique is used in developing the content of *The United States in the Modern World,* a textbook for the upper elementary grades or the junior high school. The economic actvities of the American people in relation to environmental conditions and the relation of American economic interests and problems to the rest of the world are emphasized. There are a series of eight units. Each unit includes a preview in which a few pertinent questions relative to the unit are asked. At the end of each unit is a series of exercises and problems. The appendix has a series of selected reference reading material listed by units.

Attractive in appearance, excellently illustrated, so organized as to arouse and maintain the student's interest, and up-to-date in its teaching techniques, this book ought to appeal both to the pupils studying the book and to the teachers teaching it. —C.M.P.

Dodge, Richard Elwood and Lackey, Earl Emmet. *The World and Its People.* Chicago: Rand, McNally and Company, 1932. 167 p. $0.88.

Believing that the journey or type-study treatment of geography is the best approach to the introduction of geography into the elementary grades, the authors of this beginning book in geography take trips into many lands to see how different people live. Teaching devices utilized are similar to those used in the two books reviewed above. However this text has special teaching suggestions for the teacher at the end of each text unit. This is a most readable book, excellently illustrated. —C.M.P.

Bodley, G. R. *Geography Workbook: Peoples of Other Lands.* Syracuse, New York: Iroquois Publishing Company, Inc., 1929. 59 p. $0.40.

This is a fourth grade workbook to accompany the author's *Peoples of Other Lands.*

—C.M.P.

Dukelow, Jean H. and Webster, Hanson H. *The Ship Book.* Boston: Houghton Mifflin Company, 1931. 280 p. $2.00.

This is excellent supplementary reading for pupils interested in boats, and what child is not interested in boats? Part I tells about "Ships and what they do"; Part II, "Ships and how they came to be"; Part III, "What all young sailors should know." The book is simple enough for fifth grade pupils, for some fourth grades, but there is hardly any upper limit. The book gives a good account of different types of sailing craft, of rules of the road at sea, of safety devices, the history of early vessels, and excellent helps for those who are interested in building ship models. There are directions for sailing a boat, for making sailor's knots, and a valuable "little dictionary for sailors." Illustrations are in colors.

—W.G.W.

Webster, Hanson H. *Travel.* Boston: Houghton Mifflin Company, 1933. 440 p. $2.00.

This book is a reader for elementary grades, covering travel by air, land, and sea. Many elementary school boys are planning to be air pilots, when they grow up. This book, in its first chapter, leads the boy into a fascinating story of air travel. He is told of the wonderful flights of these famous flyers: Lindberg, Rear Admiral Byrd, and Miss Amelia Earhart. Then comes the story of the development from balloons to airships.

Land transportation begins with railroads—express trains and pullman cars; historical development of locomotives, carrying freight and mail in safety. The longest section of the book deals with "Highways and Their Vehicles." As you suspect, this covers roads, bridges, and tunnels—power derived from beasts of burden in many lands, the bicycle, motor car, bus, and trolley car. "Sailing the Sea" gives a picture of a harbor and water traffic; passenger and freight ships, river and canal boats. Water craft of other days and other peoples round out the story of water travel. This is an excellent book to recommend for collateral reading in connection with a study of transportation in general science as well as for use in elementary social science classes. There are five full page color plates and numerous black and white illustrations. —W.G.W.

Wilson, H. A. *The Mysteries of the Atom.* New York: D. Van Nostrand, 1934. 140 p. $2.50.

The greater part of this book deals with the new ideas about the ultimate particles of the microscopic structures of the universe. There is a minimum of mathematics. It is an excellent reference book for advanced classes and for the science teacher who is trying to keep up with science. A few of the chapter titles are: Matter and Electricity in the Nineteenth Century; Electrons; Protons; Structure of Atoms; Light and Photons; Waves and Particles; The New Theory of Atoms; Cosmic Rays; Space, Time, and Relativity; Relativity and Gravitation. —W.G.W.

Pilley, John. *Electricity.* New York: Oxford University Press, 1933. 248 p. $2.50.

This is a college grade book giving in sixteen chapters a presentation on the subject of electricity in a manner to arouse interest in the science. It is not written with a view to cover so much ground and prepare a student to pass an examination. It is developed on broader lines

and combines something from deductive method and something from the historical method. The subject matter includes: What is Electricity; Electrical Structure of Matter; Electrification; Induction and Capacity; The Electrical Field; Discharges; Electric Currents; Magnetism; Electromagnetic Induction; Oscillatory Currents; Radiations. The book is well illustrated with fine drawings and excellent halftones. The book is very helpful in bringing the newer theories into the foreground in explaining common electrical phenomena. —W.G.W.

BAXTER, TOMPSIE and YOUNG, BESS M. *Ships and Navigation.* New York: Bureau of Publications, Teachers College, Columbia University, 1933. 219 p. $2.00.

In this book the authors show how a fifth grade class attending Lincoln School of Teachers College, Columbia University, traced the evolution of present day ships and navigation. They consider in a clear manner various problems related to the introduction and development of a unit of work. They indicate clearly how the theme measures up to the criteria set for the selection of units of work by the Elementary Department of Lincoln School. They show the ways in which different subjects of the curriculum function in the process of building up meanings necessary to carry out various activities in the unit and point out opportunities that are offered in the progress of the unit for the development of desirable social attitudes and habits of work.

A valuable content outline on ships and navigation is given together with an extensive bibliography for children and teacher. Many photographs illustrate various phases of the study.

This excellent book gives an insight into a method of work used in Lincoln School. It is valuable to every teacher interested in the work in elementary schools. —F.G.B.

WHITE, E. GRACE. *General Biology.* St. Louis, Missouri: The C. V. Mosby Company, 1933. 615 p. $3.00.

This text for the beginner in college biology provides ample descriptive matter for reference and comparison. The subject is introduced by observing known types of life rather than by cell study which brings the sudent at once into an unfamiliar field. The grasshopper is studied at first. Specimens are easily obtained and observation in its natural state is readily made.

Part 1 discusses The Unit of Life; Part 2, Progressive Organization; Part 3, Problems of Biology. Under Problems of Biology, the fundamental concepts of life and interesting biology problems of the day are discussed at considerable length. The book is mechanically well made. The many illustrations are excellent. The glossary of thirty-two pages is a useful part of the text. —W.G.W.

JAUNCEY, G. M. *Modern Physics.* New York: D. Van Nostrand Company, 1932. 568 p. $4.00.

There is no physics subject matter in college that has the fascination and holds the interest of students as does that relating to the newer thinking, bringing in as it does such live matters as x-rays, quantum theory, cosmic rays, relativity, radio, and the television. Too often these are left for the senior year but many do not continue physics that long. Much fundamental knowledge must be gained before one can profitably undertake the study of these modern physical theories. This text has been prepared for use in the second year with students who have had one year of regular college physics of the classical physics type. It deals largely with subject matter having to do with "atomic physics" but it is by no means restricted to that field. —W.G.W.

ZIMMERMANN, ERICH W. *World Resources and Industries.* New York: Harper and Brothers, 1933. 842 p. $4.00.

This is not an economic geography as that term is generally understood. It is rather a study of economic life as it relates to underlying physical causes. The human, social, cultural and economic phases of geography are presented in relation to their economic meanings. The material is treated from a functional approach. An attempt has been made "to synthesize some of the findings of the various sciences, to integrate data generally found in widey separated places." The treatment is more philosophical and probably more sociological than is ordinarily found in a work of this kind.

It would seem to be a book more suitable for advanced economic and geography students than for those taking elementary courses in these subjects. Science teachers interested in world resources and industries, as well as geography teachers, will gain a new insight into the cultural and economic importance of world resources through reading this book. Altogether the book gives an unusual appraisal of the resources of the world. —C.M.P.

HUNTINGTON, ELLSWORTH, WILLIAMS, FRANK E. and VAN VALKENBURG, SAMUEL. *Economic and Social Geography.* New York: John Wiley and Sons, Inc., 1933. 630 p. $3.00.

The underlying concept which forms the basis for this textbook is that climate, relief and soil are the main determinants of the geographic regions into which the earth's surface may be divided naturally. Each of these determinants is given quite adequate treatment. As indicated in the title, more attention is given to social geography than in the usual economic geography textbook.

The statistical treatment is comparative rather than exact. There are many excellent maps and graphs, but a complete absence of pictures. This omission is probably not serious in those departments of geography having adequate visual aids

material, but to those department not quite so fortunate and to many teachers of geography using the book for supplementary reference purposes, this omission is to be regretted.

Part I, which treats the major geographic factors and principles, is especially good. Cause and effect reationships are well developed here. Part II gives a survey of the natural regions. Part III describes the world's great products and Part IV is devoted to industry and commerce.

—C.M.P.

Whitbeck, Ray H. and Thomas, Olive J. *The Geographic Factor.* New York: The Century Company, 1932. 422 p. $2.25.

Reminiscent of that classic—Huntington's *Civilization and Climate*—this most recent book on the influence of natural environment on human affairs will be welcomed as supplementing that earlier work. Each aspect of the environment is presented in connection with the cultural adjustments made under its influence. Environment is presented as having, not a mandatory influence, but rather a permissive influence. Consequently the treatise has much of the philosophy of geography as its background. Not only are climate, geographical barriers, and geographical location presented as factors of the geographic environment, but also the importance of iron, oil, coal and other material resources are represented as having a revolutionizing influence.

Teachers of geography and others who are desirous of learning something of the philosophy of geography and of the broad, fundamental relationships coordinating life with the surrounding geographic factors, will find in this non-technical treatment the book they have been seeking.

—C.M.P.

Ridgley, Douglas C. *Rainfall of the Earth.* Bloomington, Illinois: McKnight and McKnight, 1933. 47 p. $0.20.

This pamphlet treats the rainfall of the whole earth in its relation to wind belts and physical features, with detailed study of the rainfall of each continent. It is intended for use in geography classes in the upper grammar grades, junior and senior high schools, and in teacher-training institutions. —C.M.P.

Aitchinson, Alison E. and Uttley, Marguerite. *North America by Plane and Train.* Indianapolis: The Bobbs-Merrill-Company, 1931. 404 p. $0.96.

This is a geographical reader. It presents intensive studies of restricted areas which are representative of a larger region. Each area studied is given in great detail. In such treatment the authors are in keeping with the more recent trends in geography writing.

A few examples of the type areas studied include: Farmers of the Corn and Livestock Belt; From Ore Field to Steel Mill; In the Land of King Cotton; Oil Fields of the South; Our National Playgrounds; Falling Giants of the Northwest; Feeding the Manufacturing East; The Great Wheat Fields; Porto Rico, One of Uncle Sam's Sugar Bowls.

The books is written in a narrative style that will greatly appeal to children in the upper elementai, grades and junior high-school levels. Many excellent pictures add to the book's attractiveness. The authors have not sacrificed accuracy in their presentation of an America that will be real in the minds of those reading this account. —C.M.P.

Thomas, Katheryne Calvin. *Asia, the Great Continent.* Indianapolis: The Bobbs-Merrill Company, 1931. 420 p. $0.96.

This geographical reader does for Asia what *North America by Plane and Train* did for that continent. It is written in the same pleasing narrative style and has its share of excellent pictures, pertinent to the subject being discussed. The account seems to compare favorably in accuracy with other descriptions of that vast, scarcely known continent. Very little is really known concerning the continent of Asia as a whole, that no geographer has attempted to write an accurate description of it. The very few texts that have been attempted are admittedly far from being accurate. The "unconquered Everest" of the time the book was written, cannot now be so described.

—C.M.P.

Carpenter, Frances. *Our Neighbors Near and Far.* New York: American Book Company, 1933. 222 p. $0.96.

This is the first of a four-book series of geographies on *Our World and Ourselves.* In a series of imaginary journeys, the pupil takes a trip across the United States, to the moist Amazon Valley, the cold Arctic, the hot and dry Sahara, the garden of the Nile, the rain forests of the Congo, the highlands of Switzerland, the lowlands of the Netherlands, and to many other lands.

The style is narrative. In each type or region, the reader is made acquainted with a boy and girl of that region and through them is enabled to understand their differing ways of living.

One of the most meritorious features of the book is series of excellent pictures. They add much to the attractiveness and teachability of the book. Sometimes it seems as if the vocabulary could have simplified, and one wonders if too much has not been attempted, and too much taken for granted. It might have been better to have omitted some material and to have given the remainder more adequate treatment.

Various teaching aids include: (1) Questions and Exercises; (2) Completion Tests; (3) Globe and Map Reading; (4) Museum Collection Suggestion; (5) Correlation with History, and (6) Summaries and Reviews. —C.M.P.

Brigham, Albert Perry and McFarlane, Charles T. *Our Home State and Continent*, 1933, 330 p., $1.32; *Our Continental Neighbors*, 1933, 390 p. $1.62; and *How the World Lives and Works*, 1933, 406 p. New York: The American Book Company.

The three books complete the series *Our World and Ourselves*. They may be taken as typical representatives of the statement that there exists no longer a dearth of excellent geography textbooks in the elementary field. Such a statement cannot as yet be made about the senior high-school or college field. Much progress has been made within the last decade in writing elementary geography textbooks.

Our Home State and Continent is intended for grade 5; *Our Continental Neighbors* for grade 6; and *How the World Lives and Works* for grade 7. Emphasis is placed upon visualization of the region studied and upon the interpretation of significant geographic relationships.

Teaching aids include numerous and excellent maps and pictures; problem questions and projects; completion tests; map, globe and graph study; reading references; and summaries, reviews and comparisons. —C.M.P.

Branom, Mendel E. *Geography Problem-Projects*. Chicago: A. J. Nystrom and Company, $0.15 each.

The Branom geography problem-projects are designed for use in the upper grammar grades and are intended to develop the idea of relationships. Such factors as land forms, surface features, soils, heat, rainfall, plant life and location are emphasized. Much map work is involved in working out each problem-project. Each unit contains six or seven projects. The following units are available: New England States; Middle Atlantic States; Southern States; North Central States; Western States; North America; South America; Europe; Australia and New Zealand; Africa and Asia. —C.M.P.

McConnell, W. R. *Study Guide Lessons in Geography. Eastern Hemisphere*, 1931. 126 p. $0.27; *Western Hemisphere*, 1931, 157 p., $0.30; Book I, *The United States and Neighboring Lands*, 1932, 128 p., $0.30; Book II, *South America*, 1929, 70 p., $0.18; Book III, *Europe*, 1931, 112 p., $0.28; Book IV, *Asia, Africa, Australia, and New Zealand*, 1931, 72 p., $0.18. St. Louis: Webster Publishing Company.

This series of six study guide lessons in geography is designed to accompany any textbook in geography. The purpose of each book is to enlarge and enrich the study of geography. There are a variety of exercises with numerous maps and diagrams. Problem-solving is emphasized throughout. According to the author the material "has been carefully tested in actual classroom work with many different groups of children." —C.M.P.

Brown, Robert M. and Thorp, Mary Tucker. *Directed Geography Study*. Book I, *The Western Hemisphere*. 180 p. Book II, *The Eastern Hemisphere*. 180 p. Yonkers-on-the-Hudson: World Book Company, 1933. $0.56.

These two workbooks give a complete survey of the world. Book I contains seventeen units and Book II has twenty-two units. There are questions to answer, maps to make, graphs to copy, journeys to take, topics for class discussion, and outlines for individual study. Each unit gives cross-references to a series of geography textbooks and supplementary readers which are listed near the beginning of each workbook. Both workbooks can be used very advantageously in upper grammar, junior high-school and senior high-school geography classes. —C.M.P.

Blanchard, W. O. *Exercises and Problems in Elementary Economic Geography*. New York: McGraw-Hill Book Company, 1933. 72 p. $1.00.

This manual is designed to supplement the ordinary textbook study and classroom recitation in an elementary college course in economic geography. Other teachers of geography will find the exercises and problems quite useful. The utilization of this manual will serve to alleviate the routine of text assignments and add much to the interest of the geography course. It is almost certain that students using it will have acquired an enriched background of geographical knowledge. The questions are pertinent and thought-provoking. —C.M.P.

Tyrell, James F. *Tyrell's Geography Completion Exercises*. Boston: The Palmer Company. $0.20.

There are fifty completion items in each test. Fifteen tests with keys are available, as follows: The Northeastern States; The North Central States; The Southern States; The United States as a Whole; Outlying Possessions of the U. S.; Northern Countries of North America, Canada, Newfoundland, Greenland; Southern Countries of North America, Mexico, Central America, West Indies; North America as a Whole; South America as a Whole; India, China, Japan; Asia as a Whole; Australia, New Zealand and Pacific Islands; Africa as a Whole; Europe as a Whole. —C.M.P.

Ridgley, Douglas C., Howe, George F. and Hart, Isabelle K. *Home Journeys*. Bloomington, Illinois: McKnight and McKnight, 1933. 128 p. 0.56.

This is a workbook for beginners in geography. Pupils learn about their own local environment by direct observation and investigation. *Home Journeys* is based on the association and activities of four cousins. A series of excellent pictures add to the attractiveness of the book. There are a series of ten tests to accompany the workbook as well as a list of useful reference books. Un-

questionably all teachers of beginning geography will find *Home Journeys* a most useful aid in their teaching. —C.M.P.

Ridgley, Douglas C., Howe, George F. and Hart, Isabelle K. *World Journeys.* Bloomington, Illinois: McKnight and McKnight, 1933. 128 p. $0.56.

A workbook designed for use during a year's study of the world as a whole. It has the same general plan as *Home Journeys* reviewed above. Being based on the activities of the same four cousins. A series of ten tests and a useful list of reference books are included. —C.M.P.

Ridgley, Douglas C., Swartz, David J. and Forsythe, Marion B. *At Home and Afar.* Bloomington, Illinois: McKnight and McKnight, 1933. 48 p. $0.28.

This is a workbook written especially for pupils in the schools of New York City. Part I describes how people live; Part II has to do with map work; Part II, Home Geography; and Part IV, Geographical Terms. There are eight pages of rather detailed maps of New York City. The techniques used and described here are useful to teachers of geography in as much as they may be applied to the study of cities other than New York City. —C.M.P.

Ridgley, Douglas C. and Hart, Isabelle K. *Self Tests in Geography.* Bloomington, Illinois: McKnight and McKnight, 1932. 128 p. $0.48.

This is a workbook for seventh grade pupils consisting of a series of eighty-nine self-tests, answers for scoring the test, laboratory exercises, experiments, and pupils aids. The workbook is based on the New York State Syllabus and is designed to accompany any textbook in geography. While especially useful to teachers of geography in New York state, other geography teachers will find most of the material can be adapted to their own state. —C.M.P.

Moore, Clyde B. and Wilcox, Lillian A. *The Teaching of Geography.* New York: American Book Company, 1932. 256 p. $1.40.

In the editor's introduction, Professor George D. Strayer makes the comment that "Geography is the one science commonly taught in the elementary schools of the United States." He adds that "in no other subject of the curriculum has greater improvement been made during the past quarter of a century than in the field of geography."

In this book the authors have presented the modern point of view in the teaching of geography. Part I treats of the nature, place and function of geography. Part II presents methods and procedures, and Part III is given over to materials, tests and equipment. Selected references and questions and problems for discussion are found at the close of each chapter. —C.M.P.

Vance, Rupert B. *Human Geography of the South.* Chapel Hill, North Carolina: The University of North Carolina Press, 1932. 596 p. $4.00.

The subtitle of this book is "A Study in Regional Resources and Human Adequacy." The American South is not one, but many regions, each quite distinct from the other. The major regions are: Cotton Belt and Piney Woods; Delta and Southern Highlands; Industrial Piedmont and Texas Oil Fields; Sugar Bowl and Fishing Fringe; Rich Zone and Florida Sub-tropics. Part I discusses Backgrounds: Physical and Cultural; Part II, Regions and Resources; Part III, Human Relations of Climate; and Part IV, Prospect and Retrospect.

The volume substantiates the view that through historical and cultural maladroitness the South has failed to realize its potentialities, remaining in the stage of colonial economy in the midst of modern industrialization. The author believes that without any change in population or basic natural resources, its cultural status may be greatly improved. In the final chapter he calls for a new reconstruction in the South—the Reconstruction of Regional Planning.

Probably a better understanding and appreciation of the South and its problems may be had by a reading of this book than through any other single source. It is a type of book that one interested in regional geography and the human use to which a region is put, wishes were written about similar regional areas of the United States. Its treatment is intense and concrete, rather than abstract. Geography teachers will find it the best available source of information for a real understanding of the geography of the South. Several hundred references are listed in the bibliography. —C.M.P.

Case, Earl C. and Bergsmark, Daniel R. *College Geography.* New York: John Wiley and Sons, Inc., 1932. 700 p. $4.50.

This is a survey textbook emphasizing the regional and economic phases of geography. It is intended to serve as a basic course. The first four chapters treat of the significance of climate, land forms, soils, and space relationships to human activities. Chapters five to fifteen present a study of regional geography based largely on climatic types. The remaining six chapters treat such topics as transportation, trade, fuels, minerals, and economic products of the seas.

The book is readable and teachable and has a literary style that will appeal to students. In the opinion of the reviewer it is the best college text in world geography that has yet been published. —C.M.P.

Rapson, E. T. A. *Electrical Transmission and Distribution.* New York: Oxford University Press, 1933. 179 p. $5.00.

This is a technical book with basic mathematical treatment of particular value in engineering

classes but useful also in college classes in electricity. It is based on British practice, the last chapter giving a description of the British "grid" system. It includes fourteen chapters on distribution, short and long transmission lines, economic principles of transmission, overhead and underground principles and practices, feeder protection, and considerations of travelling waves and corona effects. There are many descriptive sections which make the book valuable as a reference even in secondary schools. —A.W.H.

James, W. O. *An Introduction to Plant Physiology.* New York: Oxford Universiy Press, 1933. 263 p. $2.50.

This book is intended as a text in elementary plant physiology for the British colleges and universities. The author's statement of purpose is as follows: "This book is written for readers of senior school or junior university status, and seeks to give a balanced account of the more elementary aspects of plant physiology."

The most valuable feature of the text is to be found in the numerous well done exercises occurring at the ends of chapers. These are all of an experimental or demonstrative nature and may be carried out with quite simple apparatus. The college teacher of botany will find in these exercises a great many useful suggestions which may be carried out in his own courses. —R.K.W.

Skene, MacGregor. *School Botany.* New York: Oxford University Press, 1931. 243 p. $1.50.

This book is written as a text for British schools. It will not find wide use in American schools since botany is not widely offered as a course in American high schools and since the materials used as illustrations are often British and not easily available in this country.

Certain contrasts with American textbooks are evident. The directness, simplicity and compactness of treatment are to be recommended to authors of American textbooks. There are few illustrations, no photographic illustrations, as compared to the profuseness of pictures in American books. The line diagrams used fit in as additional interpretations of the text.

Many simple experiments and demonstrations with plant materials are described. The book will be found useful by teachers of high school biology and botany if nothing other than these demonstrations is used. —R.K.W.

Fliedner, Leonard J. *Chemistry Workbook.* New York: Globe Book Company, 1932. 35 p. $0.20.

A small book with exercises on symbols, formulas, equations and problems. The leaves are detachable and may be used by the teacher as tests. The last three exercises are short objective tests. —V.H.N.

Mendel, Martin and Brundage, Milton B. *Chemistry Experiment Sheets.* New York: Globe Book Company, 1926. 122 p. $0.67.

A manual in loose-leaf form including 59 experiments and tables of the common elements, valence, solubilities, etc. Fifteen diagrams of set-ups of apparatus are presented in the first part of the manual. These are referred to in the experiments where they are appropriate.

—V.H.N.

McCormack, J. W. and Davis, M. W. *Chemistry Laboratory Notebook.* New York: Globe Book Company, 1933. 78 p. $0.40.

A laboratory manual designed for laboratory work restricted to one period per week. Includes 36 experiments. The experiments are presented in briefest possible form. —V.H.N.

Holmyard, Eric John. *Makers of Chemistry.* New York: Oxford University Press, 1931. 314 p. $2.50.

This volume relates in interesting fashion to the history of chemistry in its development from early Egyptian days to the present. The story is largely biographical in nature, the development of chemistry as a science of the first order being described for the most part in terms of the contributions of individuals. The book may be roughly divided into four parts, namely, the early period when chemistry was largely concerned with the refining of metals; second, the period of alchemy; third, the period during which the phlogiston theory flourished and fourth, the modern period. The volume is well-illustrated and bears evidence of careful research. A good deal of more or less technical terminology and facts of chemistry are brought in. It is doubtful that the average reader with no special training in chemistry will find all the discussions interesting or even comprehensible. Some of the materials of this nature could well have been given less space to the probably greater satisfaction and enjoyment of the general reader. —V.H.N.

Dinsmore, Ernest L. *Chemical Calculations.* New York: Globe Book Company, 1927. 182 p. $1.20.

This small volume includes a large amount of material useful both to teacher and pupil in high school chemistry. Each of the first ten chapters presents essential facts about one or more of the major divisions of high school chemistry such as Matter and Changes and Atomic Structure, Gas Volumes and Units of Measurement, etc., followed by a comprehensive set of exercises and problems on those topics. The eleventh and twelfth chapters are summary chapters including a wide variety of problems and the last two chapters consist of problems from recent examinations such as those of the College Entrance Board. The problems are for the most part, of the usual types, although many seem more difficult than

those usually found in high school textbooks in chemistry. The chief value of this work would seem to be that of a source of practice and drill exercises for pupils preparing for Regents', College Entrance Board and similar examinations.

—V.H.N.

Cameron, Hector Charles. *The Nervous Child at School.* New York: Oxford University Press, 1933. 160 p. $1.75.

An interesting and readable discussion of mental and physical disturbances of English school boys and girls which are commonly met in these children when they leave home and attend boarding school. The book is written essentially from the point of view of the medical profession.

—V.H.N.

Newman, H. H. (editor). *The Nature of the World and Man.* (Revised edition.) Chicago: University of Chicago Press, 1933. 543 p. $1.00.

The revised edition of this well-known work will be more than welcome at its new low price. Ranging from the beginnings of the earth and its relation to the universe to the latest knowledge of man and his relation to the world in which he lives, each of its seventeen sections is written by a specialist in his field. This compilation forms the backbone of a survey course in science developed at the University of Chicago. It is one of the few texts which satisfactorily gives a comprehensive overview of science on a college level suitable for the student who may or may not specialize in science. —O. E. Underhill

Stenhouse, Agnes L. and Stenhouse, E. *The Science of Housecraft.* New York: Oxford University Press, 1933. 149 p. $0.95.

This book discusses building the house, clothes, heating, lighting, ventilation, cleaning and cooking, in the rather terse and almost outline form characteristic of English texts. Apparently English law is more thoughtful of the consumer than is legislation in this country. It is interesting to learn that in England

> ". . . the gas bill must state not only the number of cubic feet of gas supplied, but also the number of units of heat that gas could yield when burnt. The unit of heat used is called a therm; it is the amount of heat which would be required to make 100,000 pounds of water 1° Fahrenheit warmer. Also, the quality of the gas supplied must be such that not more than 222 cubic feet are required to yield one therm when burnt."

—O. E. Underhill

Whitlock, T. G. *Elementary Applied Aerodynamics.* New York: Oxford University Press, 1931. 233 p. $3.25.

A rather technical treatment of aerodynamics applied to the airplane. It is intended to fill the gap between popular non-technical books and advanced mathematical works. It probably goes beyond the needs of the secondary school teacher except where some teacher of physics may be especially interested in aviation.

—O. E. Underhill

Post, Augustus. *Skycraft.* New York: Oxford University Press, 1933. 276 p. $1.50.

The fundamentals of flying are presented in an exceptionally clear manner. It is profusely illustrated with most excellent photographs and clear diagrams. It is surprising how much real information is packed into each of its short chapters without loss of easy readableness. After reading the chapter on "How To Fly" one feels almost ready to step into a plane and take off. A glossary of aeronautical terms is appended and an eighteen page supplement dealing with "aviation in 1932–33" brings this book, originally copyrighted in 1930, up-to-date. It can be read with equal interest by junior-high-school students or adults. —O. E. Underhill

Fraser, Chelsea. *Heroes of the Air.* New York: Thomas Y. Crowell Company, 1932. 648 p. $2.50.

A description of the more important flights from the first flight across the Atlantic in 1919 by Commander Richardson and two other pilots in the NC–4 to the flights of Amelia Earhart, Captain von Granau's third Arctic flight, and the first solo flight from Europe to America by Captain Mollison in 1932. Both airplane and dirigible flights are narrated. As in his later book *The Story of Aircraft* (see review in this issue) the author seems to have had opportunity for unusual analysis of the innermost thoughts of those about whom he writes. It is hard to imagine Lieut. Maughan as he "muttered jovially" over his shoulder at the sun "well, old rival, we're at it again, aren't we? I'm willing to have you work around on my front after awhile; but not as fast as you did last time I came this way, please remember that!" Also as in the other book there is a certain amount of inaccurate or obscure statement which, while not detracting from its value in giving a picture of these various flights, does require that care be taken to point out these things if the book is used in connection with science classes. For example, there appears the fallacy that an aviator flying upside down will not be aware of this until he becomes dizzy from the rush of blood to his head. Certainly unless a plane were looping in such a way as to create a centrifugal force an aviator who was upside down would be aware of his weight pressing against his life belt on some other part of his anatomy than would be the case if he were right side up. Or, again the pilot does not call "contact" after the engine is running as a signal for jerking the chocks from the wheels and letting go the plane (p. 66). This is the query made by the mechanic who has turned the propeller to charge the cylinder with gasoline vapor and is ready to spin it. The pilot then turns the switch and answers with the same word indicating that the mechanic may swing the propeller. As was mentioned in regard to the other book by this author

these and other minor errors or obscure statements do not detract from the value of the book as a hisory of flying. —O. E. Underhill.

Fraser, Chelsea. *The Story of Aircraft.* New York: Thomas Y. Crowell Company, 1933. 492 p. $2.50.

A very interesting and complete account of the development of aircraft from Daedalus and Icarus to the most modern methods of air transport, this book is divided in two sections, one dealing with lighter-than-air craft and the other with heavier-than-air craft. The style is rather more wordy than necessary. The author must either have had access to rather exceptional insight into the minds of the various personages he discusses or have had access to rather complete autobiographical writings by them to have been able to reproduce so much of the dialogue and thought processes of these people.

The reviewer is not sufficiently well acquainted with the subject to judge of the accuracy of the historical matter presented. Certain errors of fact concerning the underlying science, however, would make one tend to be somewhat cautious in accepting all details. For example, it is twice stated that helium is lighter than hydrogen. "Again, America contributed helium gas, even lighter than hydrogen" (p. 187). "Besides being lighter than hydrogen helium was far safer" (p. 202). An increase of lifting power of 100 per cent is referred to as "increasing their lifting power a hundredfold," (p. 274). Fast airplanes have attained the "remarkable momentum of seven miles a minute." The Goodyear III in one of its races would "coast down a slanting air pocket." These and other similar errors or inexact expressions do not detract materially from the value of the book as a history of aviation but they do make it necessary for science teachers who may wish to use it as supplementary reading to watch out for them.

—O. E. Underhill

Stull, De Forest and Hatch, Roy W. *Our World Today.* Boston: Allyn and Bacon, 1932. 724 p. $2.00.

This is one of the most comprehensive and may be classed among the best geography textbooks that has been published. Selection of content and the techniques of teaching utilized are based on the latest findings in studies of the learning process. It is organized into well-defined teaching units. The questions and activities have received careful consideration. The pictorial illustrations and maps are excellent in quality and unusually numerous. The biographical material denotes, in its completeness and pertinancy, very careful selection. *Our World Today* merits extensive use in American schools. —C.M.P.

Stull, De Forest and Hatch, Roy W. *Geography Workbook for Our World Today.* Boston: Allyn and Bacon, 1932. 357 p. $1.00.

This rather complete workbook is to accompany the authors' *Our World Today.* Various types of learning activities are utilized in the attempt to make the geography pupil "geography conscious." Most pupils will find geography much more interesting and greatly vitalized through the use of this excellent workbook. Teachers will find it an excellent teaching adjunct. —C.M.P.

Bassett, Clara. *Mental Hygiene in the Community.* New York: The Macmillan Company, 1934. 394 p. $3.50.

This book gives the facts and discusses the status of work in mental hygiene in the United States in particular and the world in general. Twelve chapters emphasize the specific needs and practices in medicine, nursing, social-service work, work among delinquents, parental education, pre-school training, teacher training, church work, industry, recreational work, and psychiatric institutions. The book is well written and will give the reader a good conception of the importance and extent of efforts now being made to care for the problems of mental hygiene which confront us in all the areas of public and private life. —A.W.H.

Coates, Christopher W. *Tropical Fishes as Pets.* New York: Liveright, Inc., 1933. 226 p. $2.00.

Employing a pleasant readable style, the author gives the fish enthusiast a concise description of a great number of tropical fishes adaptable to the home aquarium. Mr. Coates is the Curator of the Department of Tropical Fish in the New York City Aquarium, and conducts a tropical fish column in the *New York Sun.* Presenting each family and principal species separately, he outlines their habitat; their good and bad points (which should prove helpful to the fish lover adding newcomers to his collection); their breeding habits, if known; and the differentiation of sexes, if any. Included are helpful photographs of the more important varieties, a discussion of the chemistry of the aquarium, and some common fish ailments. Of interest, also, are the methods of collecting new species in far-off countries, and the difficulties encountered in long-distance transportation. Fish actually suffer sea-sickness!

With the enthusiasm of propagating tropical fishes becoming so widespread among children, this book should prove welcome to teachers unacquainted with this new hobby. Aside from furnishing interesting new bits of teaching material, their habits offer a very attractive approach to the subject of sex education. These little creatures show no hesitancy whatsoever in

displaying all their family conventions of courting, mating, and bringing forth their young either born alive or by means of eggs. Some care for their offspring but many have the shameless ancestral habit of gobbling up the less nimble of the progeny as soon as they are born.

—Henrietta R. Wolfanger.

Walter, Eleanor Dawes, and Roberts, Helen Munsell. *Bugs.* Racine, Wisconsin: Whitman Publishing Company. $0.10.

This is a booklet of nature poems, beautifully illustrated in colors, that will delight a child of kindergarten and primary school age.

—C.M.P.

Thorne, Diana. *Dogs*; Thorne, Diana. *Baby Animals*; Shankland, Frank North, and Peat, Fern Bisel. *Birds*; Beatty, John Y., and Allen, J. C. *On Our Farm.* Akron, Ohio: The Saafield Publishing Company, 1932. $0.10 each.

The first three booklets are paintings with descriptive stories. *On Our Farm* is a picture-story book of animals found on the farm. The photographs are excellent. Primary and kindergarten teachers will find these booklets intensely interesting to children in these grades. "Your money back if not satisfied." —C.M.P.

Soddy, Frederick. *Wealth, Virtual Wealth and Debt.* New York: E. P. Dutton and Company, Inc., 1933. 320 p. $2.50.

This is an ambitious essay in economics by a great chemist. After reciting some of the triumphs of natural science, the author proceeds (Chapter four) to formulate and expose "the fallacies of orthodox economists." The distinguished chemist finds (page 70) that the analysis of wealth is too difficult a study for the economists. So he undertakes it (Chapter six) and completes it very much to his own satisfaction. He asserts that, "wealth as a form, product or result of a draft upon the flow of available energy consists of the special forms, products, or results which empower and enable human life." A professional economist is likely to regard that statement as an obscure but pretentious way of saying what we commonly teach to elementary students.

Soddy devotes most of the remainder of his book to denunciations of the bankers and of the gold standard. He would stop the banks from lending their credit, and would abolish the use of gold as money except in international exchanges. He adopts Fisher's idea of a money based upon index numbers of prices. He would start his scheme by the good old Greenbacker plan of issuing a few billions of paper money and exchanging it for an equal face amount of the national bonds. His arguments in favor of this idea are reminiscent of some of the speeches made in the Continental Congress in favor of the issue of the ill-fated currency emitted during the stresses of the Revolutionary War.

Soddy's work will undoubtedly appeal to the inflationists, to the advocates of a managed currency, and to all the proponents of the "New Economics." Doubtless there are also a good many people who will see in it an illustration of the old maxim that a shoemaker had best stick to his last.

—Lee Bidgood, *University, Alabama.*

Dunlap, Knight. *Habits, Their Making and Unmaking.* New York: Liveright, Inc., 1932. 326 p. $3.00.

This book is chiefly valuable in giving an up-to-date account of what psychologists know about learning and habit formation. The relation of habit forming and habit breaking is evident. The book includes twelve chapters, the first eight on various aspects of learning, remembering, and forgetting. The next three discuss adjustment, habit breaking, and habits of emotional response. The last chapter has the title, "Learning Ability and Intelligence." The appendix includes a quite extended bibliography together with some interesting notes on the titles of the main chapters.

The last four chapters will appeal more particularly to the lay reader. The earlier chapters are somewhat more technical. —A.W.H.

Guttmacher, Alan Frank. *Life in the Making.* New York: The Viking Press, 1933. 297 p. $2.75.

This is an excellent book giving a most comprehensive, yet concise account of present knowledge relating to sex. Many of the superstitions connected with sex lore are uncovered and displaced by information based upon the latest research findings. The six divisions of the books are, "How Life Begins," "Sexual Rhythms," "Male and Female." "Sex Determination," "Sterility and Fertility," and "Twins." While the interest is primarily upon human sex problems, much information is given from other animal forms, particularly designed to define more clearly the human problems involved.

A great virtue of the book is its clear and understandable style. Any intelligent layman will find it easy and profitable reading.

—A.W.H.

Thorndike, Edward L. *An Experimental Study of Rewards.* New York. Bureau of Publications, Teachers College, Columbia University, 1933. 72 p. $1.50.

This monograph reports the results of experiments designed to measure the effects of rewards upon the learning of certain responses, to word and other types of stimuli. When the subject responded correctly, he was rewarded in

various ways and when his response was incorrect, he was simply told that it was wrong or in some cases, punished in various ways. The results show that rewards strengthen not only the response which they immediately follow but also those preceding and those following the rewarded response. The strengthening effect reacts more strongly on the responses preceding the correct one than on those following it. In the case of punished responses, the reverse seems to hold true, the responses following the punished connection being more affected than those preceding it. The spread or scatter of the reward or punishment effects is measured by the number of stimuli in a series the responses to which the reward or punishment affects. It is stated that this spread may act as a diffusion, the responses being strengthened in proportion to their proximity to the rewarded or punished connection. The spread effect may also be a scattering in which some connections are affected more than others which may be nearer in the series to the rewarded or punished connection. The report is highly concentrated and presents a large amount of data in a small space with a minimum of explanation. —V.H.N.

Darrow, Ben. H. *Radio, The Assistant Teacher.* Columbus, Ohio: R. G. Adams and Company, 1932. 271 p. $1.80.

This book is an account of the growth of broadcasting for educational purposes beginning with the experimental reception in the Haaren High School, New York City, in 1923. Interesting accounts of various broadcasting enterprises conducted by several committees appointed for the purpose, and many suggestions on how best to use the radio in educational work are included. Some of the discussions are on purposes of educational broadcasting, preparation of educational broadcasts, presentation, classroom equipment and use, measuring the effectiveness, and the future of broadcasting. More than fifty photographs and other illustrations serve to attract the reader.

Educators who are interested in the details of radio use in instruction will find the book invaluable because of the illustrations.

—A.W.H.

Morrison, Henry C. *The Evolving Common School.* Cambridge: Harvard University Press, 1933. 62 p. $1.00.

This is the Inglis Lecture for 1933 delivered in the Graduate School of Education at Harvard University. The first part of the lecture is a concise and clear picture of the historical development of the American secondary school. The central theme of this early section is found in this statement, "The end of that road was a condition of affairs in which a succession of schools in the minds of the people came to stand for education." Current educational practice is critically reviewed as follows: "This elevation of the several schools—and even of the years within school—into things in themselves has led even the study of education itself into several beautifully paved and otherwise embellished blind alleys." These blind alleys are enumerated as the cult of adolescence; the development of tests and measurements for purposes of standardization; the division of teaching, and courses dealing with teaching, into school levels.

The development of the secondary school through the junior college is pictured as a natural development of social and economic changes. The second phase of the lecture is concerned with the consequences of recent changes. It is predicted that these changes will eventually fill the secondary schools to the saturation point, considerably beyond that reached by the present peak expansion of the high schools. The lecture closes with a redefinition of secondary education to begin with the end of primary education and terminate with the completion of general education. This, Morrison says, will be the common school of the future.

This small volume is recommended for the thoughtful reading of all school men, whether or not they finally agree with the author.

—R.K.W.

Lewis, Isabel. *Astronomy for Young Folks.* New York: Duffield and Green, 1932. 337 p. $2.00.

This is a revision of one of the most readable accounts that has been available to the layman and to the beginning student of "stars in their courses." The author, an astronomer at the United States Naval Observatory, has long been a popular contributor to the astronomy column of various magazines. After presenting the constellations month by month, the author discusses the planets, the sun, moon, comets, meteorites and some of the stars. An excellent treatise on solar eclipses is contained in an appendix of some 67 pages. The only criticism that the reviewer wishes to make is relative to the unexplainable omission of any reference to the planet Pluto. Having the revision date that the book does, this omission is regretable. The book is an excellent addition to the junior-high-school and senior-high-school library of science books.

—C.M.P.

Pinchot, Gifford Bryce. *Giff and Stiff in the South Seas.* Philadelphia: The John C. Winston Company, 1933. 241 p. $2.00.

What fun Giff and Stiff had on their voyage in the South Seas! One can easily imagine the envy with which other boys will follow their adventures on the 13,000 mile trip whose main purpose was to collect natural and scientific wonders. Giff, the thirteen-year-old author of this account, tells in a boy's language the actual experiences of himself and Stiff, his fifteen-year-

old chum. It is a story of varied adventure, with a scientific slant, in as much as the older members of the group were interested in collected fauna along the route traveled. The reviewer heartily recommends this book to every boy in his "teens" who may have any vague instincts to go "asploring." —C.M.P.

Rulon, Phillip Justin. *The Sound Motion Picture in Science Teaching.* Cambridge: Harvard University Press, 1933. 236 p. $2.50.

In this study the author gives quantitative statistical data to show that sound-motion pictures, planned to supplement the textbook in general science in ninth-grade classes, have significant effects. The data cover content in certain biological and physiographical aspects of general science. They show definite outcomes in thought, as well as in rote-content, favoring the use of sound-motion pictures. Good sound-motion pictures do not, therefore, have only superficial effects. Moreover, the data show, by means of scores from retention tests, that the effects are lasting.

The data were obtained from an experiment involving about 3000 pupils in the vicinity of Boston, included in the zero-group (uninstructed), the control group (using the prepared textbook but not the prepared films), and the experimental group (using both the textbook and the films). Carefully selected test items to favor neither experimental nor control groups were used in preliminary tests, final immediate tests, and final retention tests. The tests were made up of two-choice, and three-choice items, and statistical treatment took the guessing element into account.

Details of analytical instructional and test content selection, of group matching, of choice of teachers, of textbook and film preparation, of instructional procedures, and of statistical treatment of data, are too involved to describe or explain here; but evidence is given to indicate more than the usual degree of attention to all of these features. One might question the equality of the teachers under the conditions of the experiment, and desire scores of the compared groups in other phases of instruction after completion of the whole course, which would furnish more direct data for teacher comparison. However, the data given supply strong evidence that, when films are especially prepared to supplement instruction, their results, on the average, definitely increased achievement by pupils. —A.W.H.

St. Clair, Labert. *Transportation.* New York: Dodd, Mead and Company, 1933. 349 p. $2.50.

The purpose of the author in this book is to give a connected account of the development of methods of transportation from the beginning of history. He does this in quite interesting style, from the time when man carried his own goods to the present high speed transportation afforded by the airplane. Crude sledges, hewn-out logs for boats, chariots, carriages drawn by horses, steam railroads, automobiles, bicycles, sail boats, steam ocean liners, gasoline propelled boats, balloons, dirigibles, airplanes, rockets, and any other means of transportation of which you may think, receive attention. The effects of new methods of transportation upon civilization are also touched upon. The last chapter discusses, "The Future of Transportation." Photographs are interspersed at intervals to help the reader visualize the various stages in progress in this field. A chronological table of development of transportation on land, on water, and in the air, together with a bibliography of other references, is given in the appendix. The book is suitable for readers of junior-high-school age or older. —A.W.H.

Cooperative Test Service of the American Council on Education. *Cooperative Tests in Science.* New York: Cooperative Test Bureau.

The publications which are the outgrowth of this research project are several and varied. They include explanations of the service itself and of the philosophy underlying the project being undertaken. Some forms of the tests are now in use. Others are in the process of preparation. The following are those which have been used during 1933, which are of interest to science teachers: *Cooperative Geology Test* (Historical Geology), *Comparatice Geology Test* (Physical Geology), *Comparative Physics Test, Comparative Chemistry Test, Comparative Biology Test, Comparative General Science Test,* and *Cooperative General Science Test for College Students.* Eventually there will be ten forms of each test, all ten forms being of equal difficulty. Each test is prepared by an author or authors who have had experience in the particular field. Keys and tentative norms are available for the 1933 editions. —A.W.H.

Billet, Roy O. "Provisions for Individual Differences, Markings, and Promotion." *Bulletin, 1932, No. 17, National Survey of Secondary Education, Monograph No. 13.* Washington: Government Printing Office, 1933. 472 p. $0.40.

This is one of the bulletins resulting from the national survey of secondary education. It is of particular value and interest. Part I discusses homogeneous grouping and special classes; Part II, plans characterized by the unit assignment; Part III, other provisions for providing for individual differences, and the difficulties involved in all proposed plans; Part IV, marking and promotion. Extensive survey material has been collected to show what is being done in many of the most progressive schools of the country on

each of these large topics. It does not lend itself to a summary so brief as this review. The book is well and interestingly written and stimulating to any one who has given this matter any thought. While the author proposes no ideal plan, the many plans in use may be of service to schools in which they have not yet been tried; or they may suggest to the reader other untried ways. —A.W.H.

Deffenbaugh, W. S., and Zeigel, William H., Jr. Selection and Appointment of Teachers. *Bulletin, 1932, No. 17, National Survey of Secondary Education, Monograph No. 12.* Washington: Government Printing Office. 115 p. $0.10.

This bulletin of the national survey of secondary education gives factual data collected from the survey and some accounts of other research data collected by other research workers on former occasions. The discussions center around the numbers of new teachers appointed, qualifications of newly appointed teachers, how desirable teachers are located or discovered, what information is collected about prospective appointees, how teachers are appointed, and how teachers of high quality are retained in school systems. The monograph will be of interest to all prospective teachers, teachers in service, and those who have any hand in the appointment of teachers. —A.W.H.

Wilson, G. Lloyd. *The Transportation Crisis.* New York: Sears Publishing Company, Inc., 1933. 335 p. $2.50.

Professor Wilson is an economist of high repute both as a teacher and as a writer, in the field of transportation, and this volume will help to maintain and enhance his reputation.

The author gives a brief but careful and well-proportioned factual survey of the various transportation agencies of the country, and considers special problems which confront each of them. In addition, and characteristically, Professor Wilson stresses the natural unity of the transportation system and the inevitable reaction of one agency of transportation upon the others. The problems of the industry as a whole are set forth in the opening chapter and never lost sight of thereafter.

The suggestions offered by the author center around this idea of a coordinated national transportation system. The most important proposal is that all interstate transportation agencies be regulated "by one governmental agency—the Interstate Commerce Commission." Professor Wilson's ideas are obviously founded upon a thorough knowledge of the past history and present condition of transportation, and are sound, sober and intelligently progressive.

The book will be of interest to any citizen who wishes to acquaint himself with the transportation problem. It is not intended to serve as a complete text for introductory college courses in transportation, but rather as a supplement to the general works. It will be of service to high-school teachers of civics, economics or science, and is an up-to-date and valuable reference work for high-school or college debaters.

—Lee Bidgood, *University, Ala.*

The Carnegie Foundation for the Advancement of Teaching in Cooperation with the United States Office of Education, Department of the Interior. *Economy in Higher Education.* New York: The Carnegie Foundation, 1933. 127 p.

Part I includes three chapters on Principles treating of "Urgent Issues," "Revenue and Retrenchment," and "Higher Education and the Social Order." Part II includes five chapters on Administration referring to studies in economy, curricula, cost of instruction, research, and general finance. The Appendix contains a list of eleven tax sources as outlined by Professor Morrison of the University of Chicago. Dr. David Hill of the Foundation and Dr. Fred Kelly of the United States Office of Education collaborated in the preparation of the volume.

—A.W.H.

Spaulding, Francis T., Frederick, O. I., and Koos, L. V. "The Reorganization of Secindary Education." *Bulletin 1932, No. 17, National Survey of Secondary Education, Monograph No. 5.* Washington: Government Printing Office, 1933. 423 p. $0.40.

This is one of the bulletins resulting from the national survey of secondary education. It is likely to be a long time before we are abie to get so much for such low cost as these bulletins provide. This monograph discusses school types of organization from data collected for the survey. Part I discusses the reorganized secondary school in the various forms of junior and senior high schools and makes many comparisons between these forms. Part II discusses the junior college in its recent growth and development. Part III discusses special types of organization now being tried out experimentally in several schools. The discussions are too extensive and varied to admit of brief summary. They are almost entirely factual in nature. A list of needed investigations is given in Appendix B.

—A.W.H.

Dodge, Richard Elwood, and Lackey, Earl Emmer. *Our Neighbors Across the Seas.* Chicago: Rand McNally and Company, 1932. 219 p. $1.20.

Our Neighbors Across the Seas is a geography of the Eastern Hemisphere and is designed to follow the study of the Western Hemisphere. The method of approach is identical to that used in *Our Country and American Neighbors* reviewed above. —C.M.P.

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